1 Declaration

Site Name and Location

This Record of Decision (ROD) presents the Selected Remedy for Operable Unit (OU) 14, Site 69 at Marine Corps Installations East – Marine Corps Base Camp Lejeune (MCIEAST-MCB CAMLEJ), located in Onslow County, North Carolina. MCIEAST-MCB CAMLEJ was placed on the United States Environmental Protection Agency (USEPA) National Priorities List (NPL) effective November 4, 1989 (USEPA Identification [ID]: NC6170022580). This remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision is based on information contained in the Administrative Record[1] file for this site. Information not specifically summarized in this ROD or its references, but contained in the Administrative Record file, has been considered and is relevant to the selection of the remedy at OU 14. Thus, the ROD is based upon and relies upon the entire Administrative Record file in making the decision. As a result of the NPL listing and pursuant to CERCLA Section 120 (e)(2), USEPA Region 4, the North Carolina Department of Environment and Natural Resources (NCDENR), the United States Department of the Navy (Navy), and the Marine Corps entered into a Federal Facilities Agreement (FFA) for MCIEAST-MCB CAMLEJ in 1991. The primary purpose of the FFA is to ensure that the environmental impacts associated with past and present activities at the Base are thoroughly investigated and response actions taken when necessary to protect human health and the environment. The Installation Restoration Program (IRP) is responsible for ensuring that appropriate CERCLA response alternatives are developed and implemented as necessary to protect public health, welfare, and the environment. No enforcement activities have been recorded at Site 69.

Statement of Basis and Purpose

The Navy is the lead agency and provides funding for site cleanups at MCIEAST-MCB CAMLEJ. The remedy set forth in this ROD has been selected by the Navy, MCIEAST-MCB CAMLEJ, and USEPA. NCDENR, the support regulatory agency, actively participated throughout the investigation process pursuant to CERCLA Section 120 (e)(4)(A) and has reviewed this ROD and the materials on which it is based and concurs with this Selected Remedy.

Scope and Role of Response Action

OU 14 is one of 25 OUs under investigation in the IRP. OU 14 solely comprises Site 69. An interim ROD (IROD) was issued for Site 69 in June 2000, which included land use controls (LUCs) and monitored natural attenuation (MNA) to address the human health and ecological risks posed by volatile organic compounds (VOCs), pesticides, polychlorinated biphenyls (PCBs), and metals in groundwater and safety risks from the potential presence of buried **chemical agent** (CA). The IROD incorporated a site-specific LUC Implementation Plan (LUCIP) for Site 69 in accordance with the Memorandum of Agreement dated May 24, 1999, known as the LUC Assurance Plan.

[1] **Bold blue text identifies detailed site information available in the Administrative Record and listed in the References Table.**

An IROD, rather than a final ROD, was executed because of the reported presence of CA at the site. At the time, based on discussions with the Design Center for Ordnance and Explosives Team of the U.S. Army Corps of Engineers (USACE), the unearthing of CA would require indefinite storage somewhere at MCIEAST-MCB CAMLEJ pending final disposition and disposal alternatives for such materials, which were not readily available.

Military Munitions Response Program (MMRP) Unexploded Ordnance (UXO) Site 2 (UXO-02) (Archive Search Report [ASR] #2.201) surrounds and encompasses Site 69. An Expanded Site Investigation for UXO-02 was completed in 2012 and concluded **no further action** (NFA) for the portions of UXO-02 located outside of the Site 69 fence (CH2M HILL, 2012). The portions of UXO-02 located within the Site 69 fence are being addressed by this CERCLA remedial action due to the potential presence of munitions and explosives of concern (MEC).

This ROD documents the final remedial action for Site 69 and documents site closure with NFA for UXO-02. Information on the status of all the OUs and sites at MCIEAST-MCB CAMLEJ can be found in the current version of the Site Management Plan in the Administrative Record.

1.1 Selected Remedy

Assessment of the Site

Previous investigations have identified the presence of waste in-place and constituents of concern (COCs), including VOCs, pesticides, PCBs, and metals in groundwater at concentrations that pose a potential threat to human health under future residential and industrial land use scenarios. Principal threat waste (PTW) is assumed to be present within the buried waste containing potential CA and dense non-aqueous phase liquid (DNAPL).

The Selected Remedy for Site 69 includes capping to contain waste and associated soil and to provide a barrier for potential receptors and infiltration, MNA and long-term monitoring (LTM) of groundwater, and updating and maintaining LUCs to prevent exposure. The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and uses permanent solutions to the maximum extent practicable. The remedy does not satisfy the statutory preference for treatment as a principal element because the potential presence of CA material within the buried waste deems removal or treatment to be impractical and/or the costs extraordinarily high. There is also a high risk associated with removal and transportation of CA and limited acceptable disposal facilities. Leaving the potentially buried CA in the ground may be preferable to excavation and destruction per the *Programmatic Environmental Impact Statement: Destruction of Non-Stockpile Chemical Warfare Materiel Containing Chemical Agent* (FR. Oct. 18, 1996 [Volume 61, Number 203]). Therefore, a cover will be installed to minimize infiltration and resulting contaminant leaching to groundwater. Although technologies are available to treat the potential DNAPL, the waste will remain in-place as a continuing source, there are unknown risks associated with chemical reactions of any injected materials with the CA, and there is uncertainty of the ability for subsurface injections to distribute reagents uniformly at acceptable quantities. Trends over time indicate that MNA will be effective and degrade VOCs in groundwater in a reasonable timeframe. The groundwater is not used for drinking water and LUCs will prevent exposure to waste and groundwater.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment in accordance with CERCLA Section 121(c) and the NCP at 40 *Code of Federal Regulations* (CFR) 300.430 (f)(4)(ii). If the remedy is determined not to be protective of human health and the environment because, for example, LUCs have failed or treatment is unsuccessful, then additional remedial actions would be evaluated by the FFA parties and the Navy may be required to undertake additional remedial action.

1.2 Data Certification Checklist

The following information is included in the Decision Summary, Section 2 of this ROD and additional information can be found in the Administrative Record file for MCIEAST-MCB CAMLEJ, Site 69:

- COCs and their respective concentrations (Section 2.6)
- Baseline risk represented by the COCs (Section 2.6)
- Cleanup levels established for COCs and the basis for these levels (Section 2.8)
- How source materials constituting principal threats will be addressed (Section 2.7)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (Section 2.5)
- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy (Section 2.10)
- Estimated capital; annual operation and maintenance (O&M); and total present worth costs, discount rate, and the number of years for which the remedy cost estimates are projected (Section 2.9)
- Key factor(s) that led to selecting the remedy (i.e., describing how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (Section 2.10)

If contamination posing an unacceptable risk to human health or the environment is discovered after execution of this ROD, the Navy will undertake all necessary actions to ensure continued protection of human health and the environment.

1.3

This ROD presents the Selected Remedy for Site 69, OU 14 at MCIEAST-MCB CAMLEJ, located in Onslow County, North Carolina.

10 MAY 2013

THOMAS A. GORRY
Brigadier General, U. S. Marine Corps
Commanding General
Marine Corps Installations East—Marine Corps Base Camp Lejeune

Date

6/25/13

Franklin E. Hill, Director
Superfund Division
United States Environmental Protection Agency, Region 4

Date

With concurrence from:

5-28-13

Dexter R. Matthews, Director
Division of Waste Management
North Carolina Department of Environment and Natural Resources

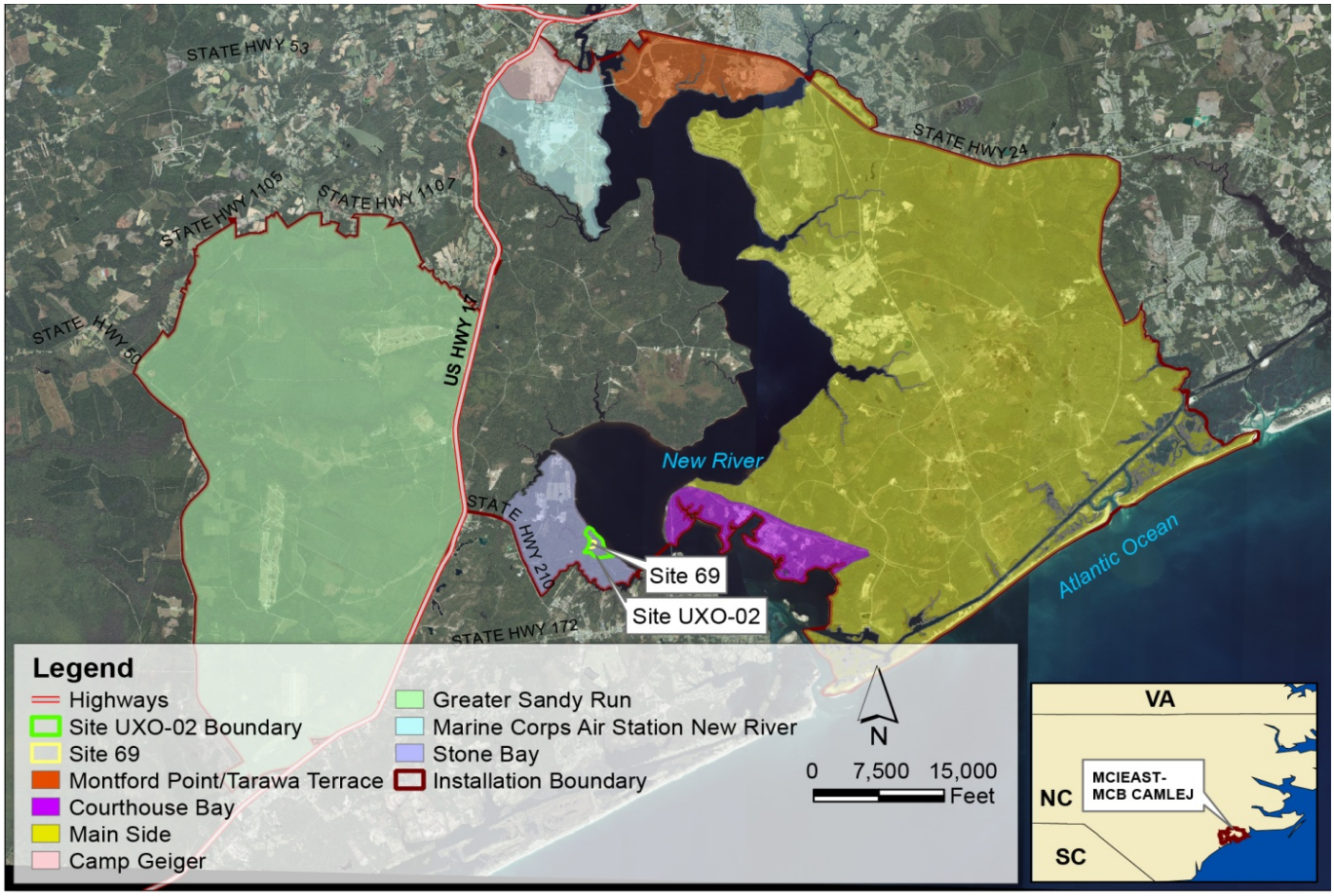
Date

2 Decision Summary

2.1 Site Description and History

MCIEAST-MCB CAMLEJ is a 156,000-acre facility located in Onslow County, North Carolina, adjacent to the southern side of the City of Jacksonville (**Figure 1**). The mission of MCIEAST-MCB CAMLEJ is to maintain combat-ready units for expeditionary deployment. The Base provides housing, training facilities, and logistical support for Fleet Marine Force Units and other assigned units.

FIGURE 1
Base Map



Site 69, the Rifle Range Chemical Dump, is located within OU 14, west of the New River in the Stone Bay area of MCIEAST-MCB CAMLEJ (**Figure 2**). Site 69 encompasses approximately 14 acres and is covered with vegetation and is heavily wooded with primarily pine, dogwood, and oak trees. The perimeter of Site 69 is surrounded by a 6-foot-high chain-link fence with a locked access gate. The site is secluded and unoccupied; however, training exercises are periodically conducted throughout the surrounding area.

Site 69 is located within the boundary of UXO-02, the Unnamed Explosive Contaminated Range (**Figure 1**). UXO-02 is a 127-acre wooded area, with some lightly forested areas supporting dense undergrowth and other more-densely forested areas with sparse undergrowth. Much of the low-lying area consists of wetlands that discharge into the New River.

From 1950 to 1976, Site 69 was reportedly used to dispose of chemical wastes that included PCBs, solvents, and pesticides. Based on available documentation, Site 69 may also have a history of CA disposal, but formal documentation of disposal methods, particularly related to CA, is unavailable. CA detector kits were observed

during a 1982 site visit; however, these are not a potential source of CA. In 1982, an interview with a former heavy equipment operator indicated that drums of possibly nerve or mustard agent were buried in trenches at Site 69. A disposal incident reportedly occurred in 1953 or 1954, when approximately 50 to 60 drums of suspected agent were reportedly delivered to the site on rubber-padded trucks and disposed of in two trenches, each approximately 20 feet (ft) deep. The unmarked drums were light-blue or blue-green in color and were stacked in the trenches so the top layer of the drums was approximately 5 or 6 ft below ground surface (bgs). According to historical documentation detailed in the Site Investigation (SI), a second disposal incident occurred in 1970 when 5-gallon cans and 55-gallon drums of dichlorodiphenyltrichloroethane (DDT), trichloroethene (TCE), and calcium hypochlorite were placed together in a common pit. As soil was being placed over the containers, an explosion occurred, resulting in a brush fire and ejection of drums as far as 120 ft from the pit.

The source area at Site 69 is the former waste disposal area. The primary contaminants in groundwater at Site 69 are **chlorinated volatile organic compounds** (CVOCs). The concentrations of COCs in groundwater samples collected from IR69-GW15IW, installed through the waste material, which are two to three orders of magnitude greater than the groundwater in all surrounding monitoring wells, and the continued presence of buried waste at the site suggest that soil within the waste disposal area is contaminated. **Figures 2 through 4** depict the approximate location of the waste disposal area, the respective extents of the VOCs, pesticides and PCBs, and metals in groundwater and the current LUC boundaries currently in place per the IROD for Site 69.

FIGURE 2
CVOC Exceedance Map

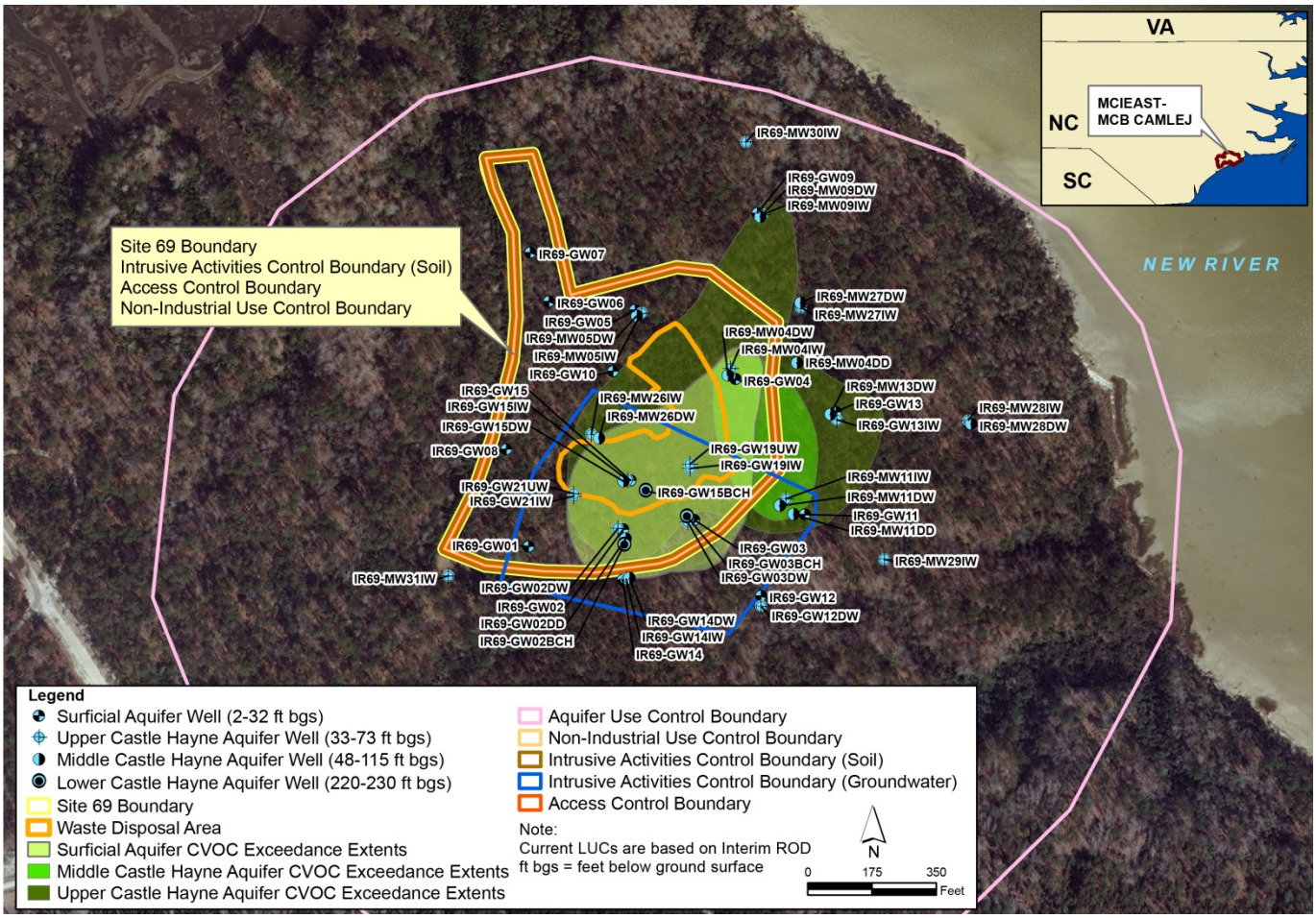


FIGURE 3
Pesticide and PCB Exceedance Map

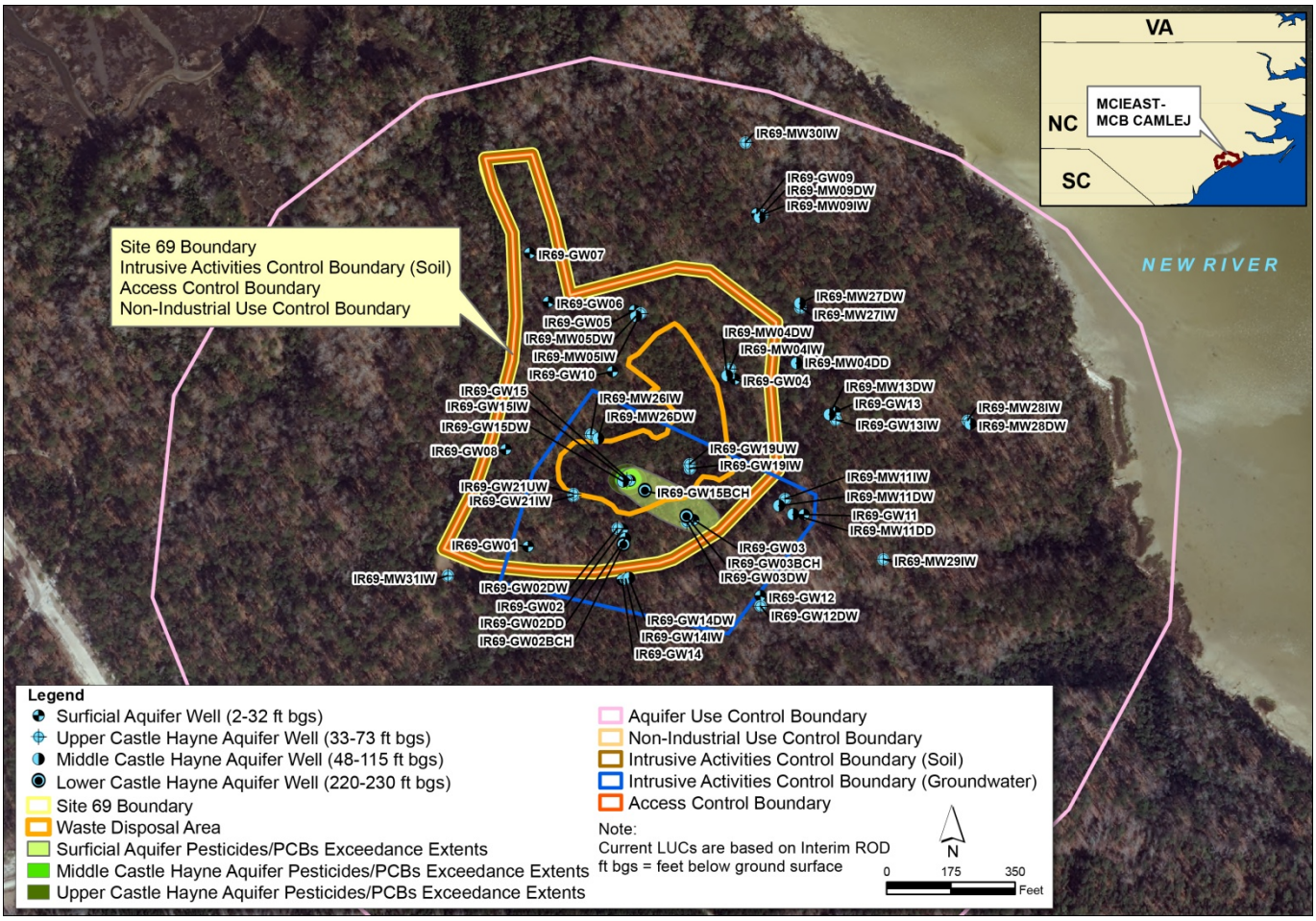
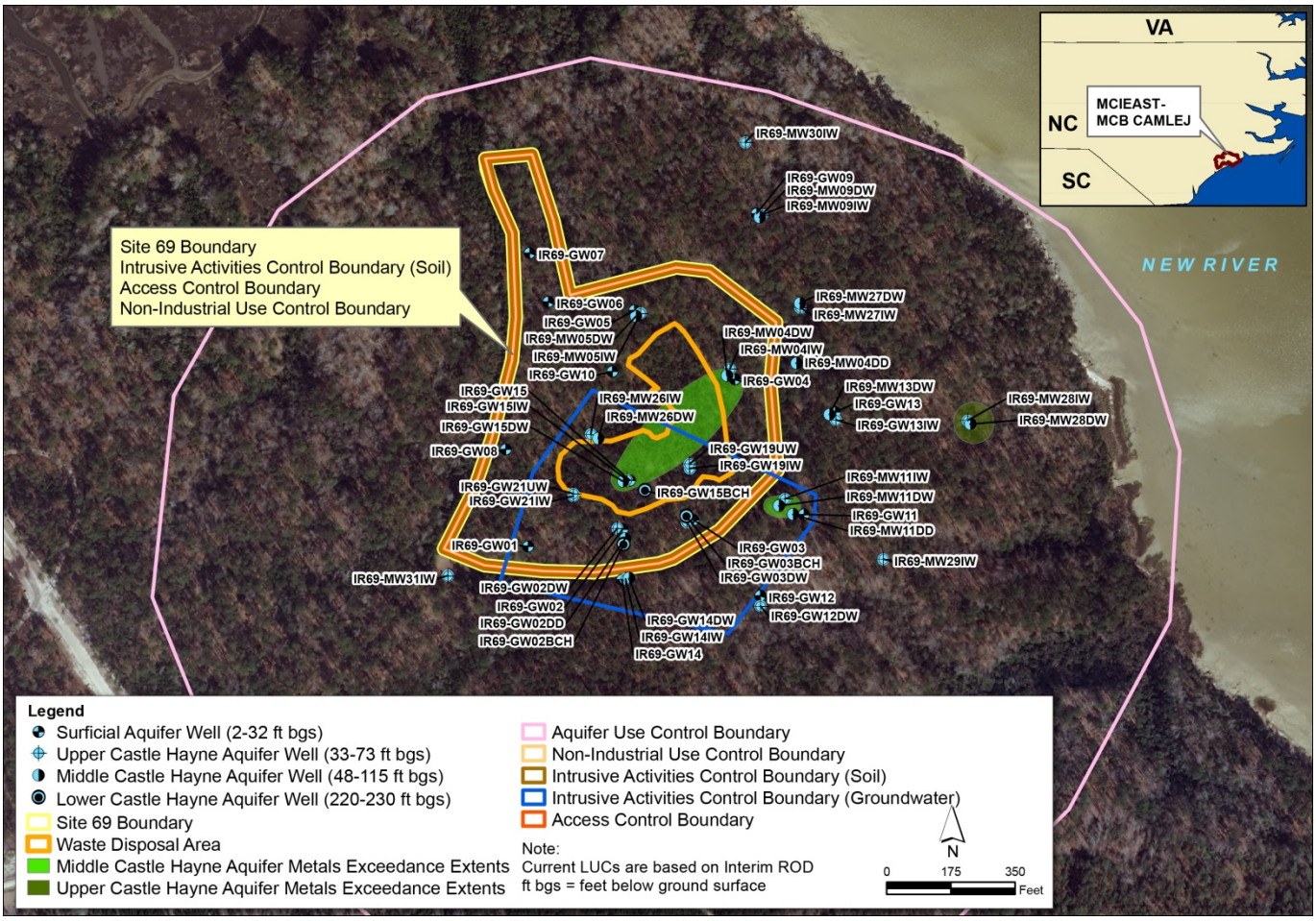


FIGURE 4
Metals Exceedance Map



2.2 Site Characteristics

Site 69 is located in a wooded area and enclosed by a 6-foot-high chain-link fence to prevent site access. The area is overgrown to the point that the boundary of the former dump is not easily discernible. Within the fenced area, evidence of trench disposal activities is present in the form of shallow, elongated surface depressions, and slumping associated with settlement. The surface and outer perimeter of Site 69 is unpaved, although a dirt road leads to the site and continues around the perimeter fence.

Site 69 consists of wooded land that occupies the crest of a low-lying, west-east-trending ridge that gently slopes toward the east and the New River. Ground surface elevations range from 20 to 38 ft above mean sea level and drainage features to the northeast and southeast of Site 69 convey surface water to the New River. Three surface water bodies lie within a quarter-mile of the site—the New River to the east, an unnamed tributary of the New River to the north, and Everett Creek to the south. Also, the wooded areas east of the site are bisected by numerous small streams and drainage features.

The geology in the vicinity of Site 69 consists of three distinct formations (Undifferentiated Sediments, the Belgrade Formation, and the River Bend Formation), which correspond to the surficial aquifer, Castle Hayne semi-confining unit, and Castle Hayne aquifer, respectively. The uppermost Undifferentiated Sediments consist of mostly fine-grained, loose, poorly graded sand, with lesser amounts of silt and clay, present at depths of 6 to 18 ft bgs. The Belgrade Formation, the semi-confining unit of the Castle Hayne aquifer, lies directly under the Undifferentiated Sediments and ranges in thickness from 12 ft near the New River to 30 ft in the central portion of

the site. The upper portion of the River Bend Formation underlies the Belgrade Formation and is composed of sands, silt, shell, and fossil fragments.

Groundwater investigations completed at Site 69 have focused on the surficial aquifer and underlying Castle Hayne aquifer. For the purposes of the ROD, the aquifer **hydrogeologic units** at Site 69 have been designated as four zones corresponding to the following depths: surficial aquifer from 2 to 32 ft bgs, upper Castle Hayne aquifer from 33 to 73 ft bgs, middle Castle Hayne aquifer from 48 to 115 ft bgs, and lower Castle Hayne aquifer from 220 to 230 ft bgs. Groundwater in the surficial aquifer flows radially outward from the center of Site 69, and groundwater in the upper and middle Castle Hayne aquifers generally flows to the northeast. The geometric mean hydraulic conductivity calculated for the surficial aquifer was 0.32 ft per day (ft/day), and the geometric mean for the upper Castle Hayne aquifer was 1.3 ft/day. These values are consistent with expected values of hydraulic conductivity for the well-sorted fine sands observed at the site.

LUCs are in place to restrict intrusive activities to prevent exposure to waste and associated soil and groundwater, prevent non-industrial land use, and prevent aquifer use. Site access is restricted by institutional controls, including a fence with a locked gate and signs.

2.3 Previous Investigations

Site 69 was characterized under numerous investigations between 1981 and 2012. **Table 1** presents a chronological list and brief summary of previous investigations and actions taken to evaluate and address site contamination.

TABLE 1
Previous Investigations and Actions

Previous Investigation/Action*	Administrative Record Number	Dates	Activities and Findings
Rifle Range Wastewater Treatment Plant and Chemical Dump Sampling (Navy 1981, 1982)	000376, 000373	1981–1982	Representative samples were collected from surrounding water supply wells, existing monitoring wells, and surface water. Analytical results indicated CVOCs and trihalomethanes were present in groundwater.
Initial Assessment Study (WAR, 1983)	000377	1983	The Rifle Range Chemical Dump (Site 69) was identified as a priority site for further investigation because of historical disposal activities at the site.
Confirmation Study (Environmental Science & Engineering, 1992)	000273	1984–1991	Surficial groundwater, surface water, sediment, and shellfish samples were collected. Analytical results indicated that VOCs, including TCE, trans-1,2-dichloroethene (DCE), and vinyl chloride (VC) were present in groundwater in the southern portion of the site and in the surface water. Results of the sediment and shellfish tissue analyses were inconclusive.
Remedial Investigation (RI) (Baker, 1997)	001761-001763	1992–1996	A geophysical investigation was conducted near suspected disposal trenches and monitoring well cluster IR69-GW02, confirming their location. Surface soil, subsurface soil, surface water, sediment, and groundwater (surficial, upper Castle Hayne, middle Castle Hayne, and lower Castle Hayne aquifers) samples were collected. Analytical results indicated VOCs were present above North Carolina Groundwater Quality Standards (NCGWQS) in the surficial, upper, and middle Castle Hayne aquifers in the southern portion of the site, with the highest concentrations in the vicinity of monitoring well IR69-GW15.

TABLE 1
Previous Investigations and Actions

Previous Investigation/Action*	Administrative Record Number	Dates	Activities and Findings
Treatability Study (Baker/SBP, 1998)	001792	1996–1997	Vacuum vaporizer well (UVB) and coaxial groundwater ventilation (KGB) **treatment systems** were installed to evaluate these technologies as potential remedial alternatives. The UVB system was successful in reducing concentrations in the treatment well but not widespread, and the KGB system failed to operate and perform consistently.
Feasibility Study (FS) (Baker, 1998)	002308	1997	Remedial alternatives, including no action, institutional LUCs for soil and no action, LUCs and natural attenuation, groundwater extraction and physical treatment, dual-phase vacuum extraction, and in-situ air stripping for groundwater, were analyzed. Soil and waste removal was determined not to be a viable option because of cost, safety, and logistical issues associated with the potential CA buried in the disposal trenches.
		1990s	A 6-foot-high chain-link fence was installed around the site to prevent unauthorized access.
IROD (Baker, 2000)	003005	2000	The selected interim remedy for soil was institutional LUCs. The selected interim remedy for groundwater was institutional aquifer use controls and MNA. The remedy included 5 years of quarterly sampling for 24 monitoring wells screened in all aquifer zones, followed by 25 years of semi-annual sampling of 12 monitoring wells to be selected based on quarterly sampling results.
LTM (Engineering and Environment, Inc., 2005)	003911	1998–2005	Groundwater samples were collected from monitoring wells in the surficial, upper Castle Hayne, and middle Castle Hayne aquifers. Analytical results indicated that vertical migration of VOCs into the upper Castle Hayne aquifer was occurring. In 2005, the LTM Program was optimized and the LTM optimization report recommended removal of Site 69 from the program because an SI was planned.
New River Sampling		2005	Due to a request by Onslow County Commissioners, NCDENR–Division of Water Quality performed split surface water, sediment, and shellfish sampling with the Base in waters adjacent to Site 69. Based on the results, NCDENR recommended no further sampling and no advisory be issued.
Radiation Survey (New World Technology, 2007)		2007	A radiation survey was conducted within Site 69 based on the suspected dump site for the Naval Medical Field Research Laboratory on Base. The survey and sampling data both indicated no distinguishable radiation levels above background levels and that any areas that exhibited elevated radiation levels above background levels were due to naturally occurring radioactive material.
UXO-02 Preliminary Assessment/Site Inspection (CH2M HILL, 2012)	004768	2010	A digital geophysical mapping (DGM) survey was conducted outside of the Site 69 fence. An intrusive investigation was recommended to assess the nature of the identified geophysical anomalies. Surface soil, subsurface soil, groundwater, surface water, and sediment samples were collected to evaluate the potential presence and nature of impacts to environmental media resulting from historical munitions use at the site. It was recommended to further investigate groundwater for metals.

TABLE 1
Previous Investigations and Actions

Previous Investigation/Action*	Administrative Record Number	Dates	Activities and Findings
SI (CH2M HILL, 2011)	004729	2010–2011	Surface soil, subsurface soil, surface water, sediment, and groundwater samples were collected and a geophysical investigation was conducted to complete the delineation of site contamination to support a final ROD. The results of the geophysical survey confirmed the waste disposal area is within the fenced boundary. The current and historical investigative activities have consistently avoided characterization of the actual waste disposal areas because of the potential presence of CA. As a result, empirical data are not available for the soil or waste material present in this area. Monitoring and screening for CA was provided by Edgewood Chemical Biological Center. Analytical results from soil samples collected outside the waste disposal area indicated concentrations of pesticides and metals in surface soil and metals in subsurface soil exceeding risk screening criteria; metals in surface water exceeding NCSWQS; VOCs, semivolatile organic compounds (SVOCs), pesticides, and metals in sediment exceeding risk screening criteria; and VOCs, pesticides, PCBs, and metals in groundwater exceeding NCGWQS. Concentrations of cis-1,2-DCE in the upper Castle Hayne indicated the presence of a continuous source area and potential DNAPL. Additional investigation of the area and media outside of the fence boundary was planned for UXO-02.
FS (CH2M HILL, 2012)	004788	2011–2012	The following **remedial alternatives** were assessed for the waste disposal area and VOC-impacted groundwater: Waste Disposal Area Alternatives: (1) no action, (2) LUCs, (3) capping with LUCs, and (4) removal Groundwater Alternatives: (1) no action; (2) MNA/LTM with LUCs; (3) permeable reactive barrier (PRB) with MNA/LTM and LUCs; (4) enhanced reductive dechlorination (ERD) with bioaugmentation, MNA/LTM, and LUCs; and (5) in-situ chemical oxidation (ISCO) with MNA/LTM and LUCs
UXO-02 Expanded Site Investigation (CH2M HILL, 2012)	005470	2011–2012	Select pesticides were further investigated in surface soil and sediment and metals in groundwater outside of the Site 69 fence. The **Human Health Risk Assessment** (HHRA) and **Ecological Risk Assessment** (ERA) identified no unacceptable human health or ecological risks in soil, surface water, sediment, or metals in surficial groundwater. There were no unacceptable risks from exposure to munitions constituents (MC) in site media and the overall potential hazard due to encountering MEC is low. NFA is recommended for the portions of UXO-02 located outside of the Site 69 fence, and the Site 69 ROD will document site closure for the UXO-02 area.

*Documents listed are available in the Administrative Record and provide detailed information to support remedy selection at Site 69.

2.4 Nature and Extent and Fate and Transport of Contamination

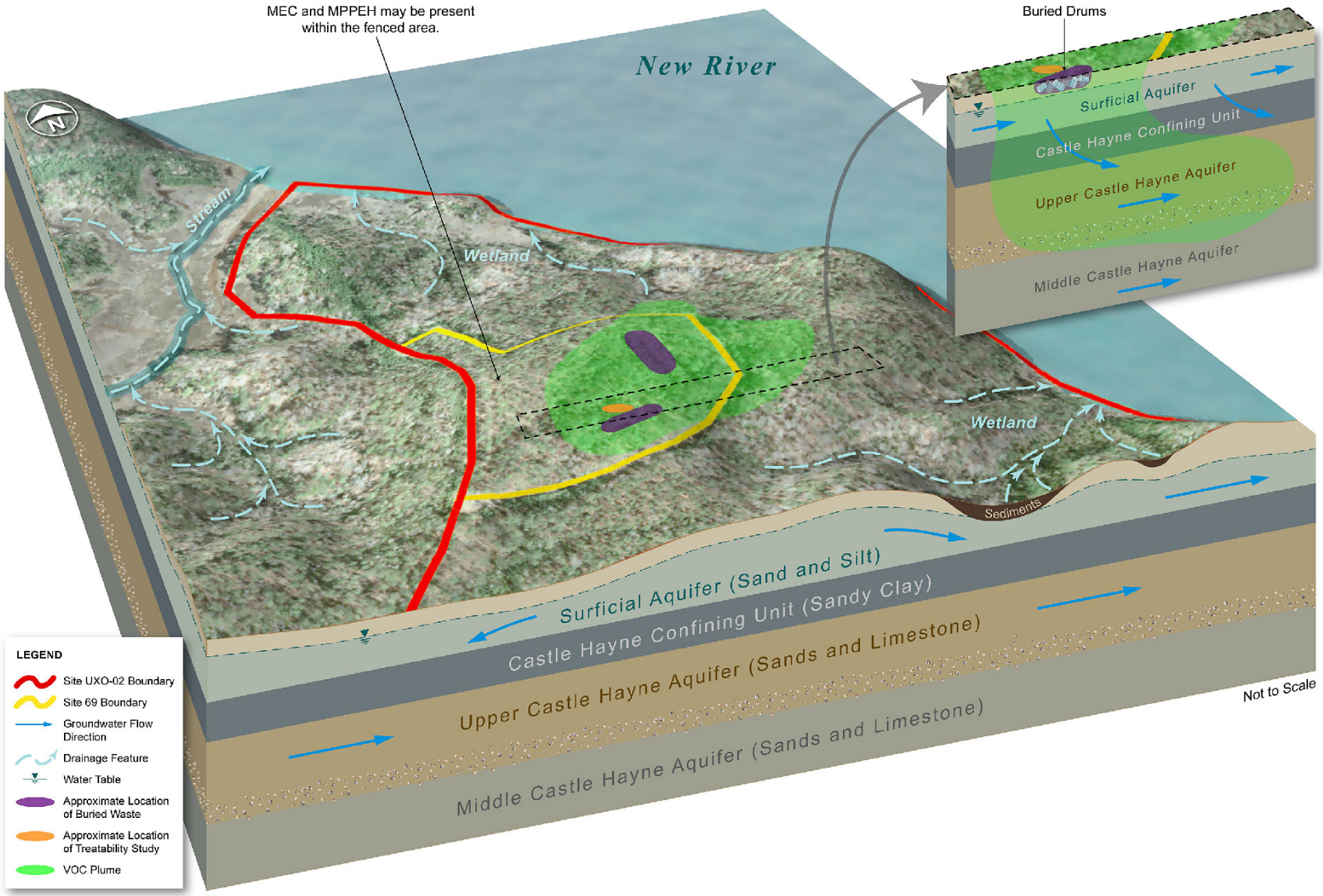
The Site 69 conceptual site model (CSM) (**Figure 5**) illustrates the extent of contamination in waste and associated soil and groundwater based on the results of previous investigations. Groundwater impacts appear primarily in the surficial and upper Castle Hayne aquifers in the vicinity of the waste disposal area and the area hydraulically downgradient.

Waste and Associated Soil

The historical investigative activities have consistently avoided characterization of the actual waste disposal areas due to the potential presence of CA. The potential presence of these reactive chemicals presents health and safety concerns associated with the release of harmful gases that could be lethal and trigger explosions or other reactions. A Determination of Applicability was completed by the Navy and United States Marine Corps in June 2009 to evaluate whether the *Interim Guidance for Biological Warfare Materiel and Non Stockpile Chemical Warfare Materiel Response Activities* (Department of the Army, 1997) applies to Site 69. It determined that there was a low probability of encountering CA if anomaly avoidance was implemented and that investigation activities could be completed as a non-CA site, which includes anomaly avoidance and near-real-time atmospheric monitoring for CA. As a result, empirical data is not available for the soil or waste material present in this area, but the concentrations of COCs in groundwater samples collected from IR69-GW15IW (1,2-dichloroethane[DCA], cis-1,2-DCE, trans-1,2-DCE, TCE, VC, and heptachlor epoxide), installed through the waste material, which are two to three orders of magnitude greater than the groundwater in all surrounding monitoring wells, and the continued presence of buried waste at the site suggest that soil within the waste disposal area is contaminated. Based on historical documentation and groundwater analytical data, the waste disposal area likely contains buried drums of PCBs, chlorinated solvents, pesticides, and potentially contains drums of CA. The soil within the waste disposal area is likely contaminated with these constituents as a result of drum leakage. The buried waste and contaminated soils are considered source materials, some of which is PTW per USEPA guidance considering toxicity as well as mobility of the wastes. Depending on the concentrations of hazardous constituents in the soil and buried wastes, such soil and waste could be considered Resource Conservation and Recovery Act (RCRA) hazardous waste or Toxic Substances Control Act (TSCA) PCB waste if removed from the landfill.

Additionally, Site 69 is located within the boundary of Site UXO-02 where MEC and material potentially presenting an explosive hazard (MPPEH) were discovered during previous investigations. Due to the waste in-place and potential presence of CA, the area within the Site 69 fence was not investigated as part of the previous MMRP investigations; therefore, MEC and MPPEH may be present within the fenced area. The area within the Site 69 fence will be excluded from the NFA determination for UXO-02 and will be included in the LUCs.

FIGURE 5
Conceptual Site Model



Groundwater

The COCs in groundwater at Site 69 include CVOCs, pesticides and PCBs, and metals. Groundwater in the surficial and upper Castle Hayne aquifers has been impacted by the following two groups of CVOCs and their degradation products: chlorinated ethanes (1,1,2,2-tetrachloroethane [PCA], 1,1,2- trichloroethane [TCA], and 1,2- DCA), and chlorinated ethenes (TCE, cis- and trans-1,2-DCE, and VC).

Exceedances in the surficial aquifer were reported for samples collected from the south-central portion of Site 69 (**Figure 2**). In the upper Castle Hayne aquifer, the greatest **concentrations of CVOCs** were also detected in samples collected in the south-central portion of Site 69, in the vicinity of the greatest density of geophysical anomalies, with concentrations decreasing in samples collected from downgradient monitoring wells located northeast and east. CVOCs were more prevalent and detected at higher concentrations in samples collected from upper Castle Hayne aquifer wells than those from surficial aquifer wells. The concentrations of all CVOCs reported in the sample collected from IR69-GW15IW, installed through the waste material, are two to three orders of magnitude higher than all other samples collected from the upper Castle Hayne aquifer.

The greatest concentrations of pesticides and metals (**Figures 3 and 4**) exceeding NCGWQS in the surficial aquifer and upper Castle Hayne aquifer were also reported in samples collected from monitoring wells located in the south-central portion of Site 69. PCBs were detected in one surficial aquifer monitoring well and chromium exceeded the NCGWQS in a sample collected from the upper Castle Hayne aquifer east of the site. Concentrations of metals that exceeded twice the mean Base background concentrations and NCGWQS were detected in all aquifers.

The potential efficacy of MNA as a remedial alternative was evaluated with a three-tiered approach per USEPA guidance, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, which analyzes the following lines of evidence: clear and meaningful trends of decreasing contaminant mass, hydrogeologic and geochemical data that demonstrate the types of natural attenuation processes active at the site, and data from field or microcosm studies. Analysis of CVOCs and natural attenuation indicator parameters (NAIPs) indicated that natural attenuation is currently occurring in the surficial, upper Castle Hayne, and middle Castle Hayne aquifers based on the following:

Historical Data

- Historical data trends from samples collected from monitoring well IR69-GW02 show an overall decrease in TCE and DCE and an increase in VC, which is strongly supportive of reductive dechlorination in the surficial aquifer (**Table 2 and Figure 6**).
- Historical data trends from samples collected from monitoring well IR69-GW15IW show a decrease in TCE and an increase in daughter products, which indicates reductive dechlorination is occurring in the upper Castle Hayne aquifer (**Table 3 and Figure 6**).
- VC is the only CVOC detected in the middle Castle Hayne aquifer above the NCGWQS, indicating that reductive dechlorination and/or migration of VC from the upper Castle Hayne aquifer is occurring.

TABLE 2
IR69-GW02 Historical VOC Concentrations

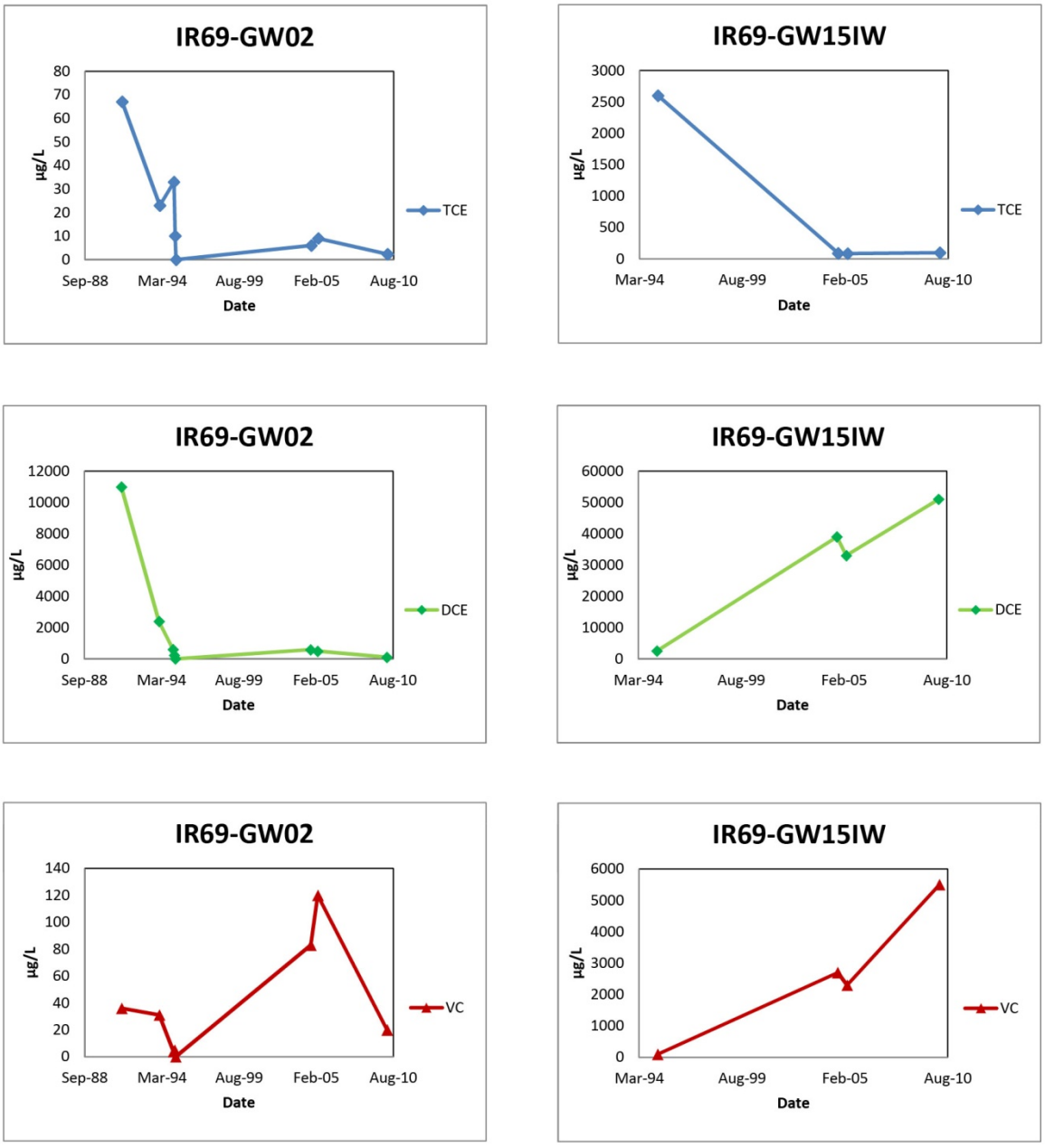
VOCs (µg/L)	Baseline (05/1991)	Current (03/2010)	NCGWQS
TCE	67	2.3	3
DCE	11,000	110	70
VC	36	20	2

µg/L = microgram(s) per liter

TABLE 3
IR69-GW15IW Historical VOC Concentrations

VOCs (µg/L)	Baseline (05/1991)	Current (03/2010)	NCGWQS
TCE	2,600	100	3
DCE	2,500	51,000	70
VC	97	5,500	2

FIGURE 6
Historical Groundwater Analytical Data Trends – IR69-GW02, IR69-GW15IW



Geochemical Data

- The surficial aquifer is naturally more aerobic and oxidizing than other aquifers at the site; however, within the plume area, groundwater is more reduced and dissolved oxygen (DO) concentrations are more favorable. The presence of ferrous iron in the surficial aquifer provides strong evidence of iron reduction, particularly in plume area wells, which had the highest concentrations. Elevated alkalinity levels at IR69-GW03 and IR69-GW15 are also suggestive of biological activity. The limited presence of ethane is evidence that full reductive dechlorination can occur. Due to the somewhat aerobic nature of the surficial aquifer, the lack of additional ethene or ethane detections is likely the result of oxidation of VC to carbon dioxide and other innocuous products (**Table 4 and Figure 7**).

TABLE 4
Surficial Aquifer NAIP Summary

Parameter	Favorable Criteria for Natural Attenuation	Plume Area		Non-Plume Area	
		Measured Range	Frequency Meeting Criteria	Measured Range	Frequency Meeting Criteria
Temperature (°C)	> 20°C	10.89–13.48	0/4	9.75–16.42	0/11
DO (mg/L)	<0.5	0.24–0.68	3/4	0.14–4.61	1/11
pH (SU)	5–9	4.58–5.33	1/4	4.21–5.26	2/11
ORP (mV)	<50	-26.1–168.0	2/4	22.0–354.1	1/11
Fe(II) (mg/L)	>1	1.0–4.4	4/4	0.0–2.1	3/11
Sulfide (mg/L)	>1	ND	0/4	ND–0.8 J	0/11
Nitrite (mg/L)	presence	ND–0.198	3/4	ND–0.099	2/11
Methane (µg/L)	>500	17 B–150 BD	0/4**	0.3 JB–16 B	0/11**
Chloride (mg/L)	> 2X background (16.8 mg/L)***	23 D–48 D	4/4	ND–20.8 D	1/11
Alkalinity (mg/L)	> 2X background (20 mg/L)****	ND–32.1	2/4	ND–20.8	2/11
Sulfate (mg/L)	<20	4.7 D–150 D	3/4	5.5–22	10/11
Nitrate (mg/L)	<1	ND	4/4	ND	11/11
TOC (mg/L)	> 20	2.2–12	0/4	0.54 J–4.5	0/11
Ethene (µg/L)	>10	ND–0.6 J	1/4	ND	0/11
Ethane (µg/L)	>10	ND	0/4	ND	0/11

*Source: USEPA, 1998

** Methane was detected in all samples at concentrations below blank concentrations.

*** Background concentration calculated from upgradient well IR69-MW14.

**** Assumed twice the reporting limit as the background concentration at upgradient well was 0 mg/L.

B = Analyte not detected above the level reported in blanks

J = Analyte present, value may or may not be accurate or precise

D = Compound identified in an analysis at a secondary dilution factor

ND = Not Detected

SU = standard units

°C = degrees Celsius

mV = millivolts

mg/L = milligrams per liter

ORP = oxygen reduction potential

TOC = total organic compounds

- The middle Castle Hayne aquifer is generally anaerobic and under predominantly reducing conditions. Geochemical data provide evidence of low levels of methanogenesis; however, other oxidation-reduction reactions appear to be limited (**Table 5**).
- The upper Castle Hayne aquifer appears to be naturally anaerobic and reduced conditions, with favorable DO concentrations. Other geochemical data indicate that iron reduction, sulfate reduction, and methanogenesis are proceeding, with the strongest evidence at IR69-GW15IW. Ethene was detected in most groundwater samples collected within plume in the upper Castle Hayne aquifer, providing evidence of full reductive dechlorination (**Table 6 and Figure 8**).

TABLE 5
Middle Castle Hayne Aquifer NAIP Summary

Parameter	Favorable Criteria for Natural Attenuation	Plume Area		Non-Plume Area	
		Measured Range	Frequency Meeting Criteria	Measured Range	Frequency Meeting Criteria
Temperature (°C)	> 20°C	17.94–18.72	0/3	16.43–20.81	1/8
DO (mg/L)	<0.5	2.24–10.31	0/3	0.12–0.73	5/7**
pH (SU)	5–9	7.59–8.37	3/3	7.24–8.32	8/8
ORP (mV)	<50	-185.3–60.3	2/3	-215.4 – -72.9	8/8
Fe(II) (mg/L)	>1	ND–0.6	0/3	ND–2.4	4/7**
Sulfide (mg/L)	>1	ND–0.4 J	0/3	ND	0/8
Nitrite (mg/L)	presence	ND–0.066	1/3	ND–0.099	3/6**
Methane (µg/L)	>500	0.7 JB–2 B	0/3***	1 B–34 B	0/6***
Chloride (mg/L)	> 2X background (29.8 mg/L)****	11 D–12	0/3	6.1 D–41	2/8
Alkalinity (mg/L)	> 2X background (374 mg/L)****	172–217	0/3	151–249	0/8
Sulfate (mg/L)	<20	17–170 D	1/3	ND–59	4/8
Nitrate (mg/L)	<1	ND	3/3	ND	7/7**
TOC (mg/L)	> 20	0.56 J–2.5	0/3	0.84 J–18	0/8
Ethene (µg/L)	>10	ND–0.2 J	0/3	ND–0.2 J	0/8
Ethane (µg/L)	>10	ND–0.3 J	0/3	ND–0.4 J	0/8

*Source: USEPA, 1998

**Parameter not analyzed for at all locations.

*** Methane was detected in all samples at concentrations below blank concentrations.

**** Background concentrations were calculated from upgradient well IR69-MW14DW.

TABLE 6
Upper Castle Hayne Aquifer NAIP Summary

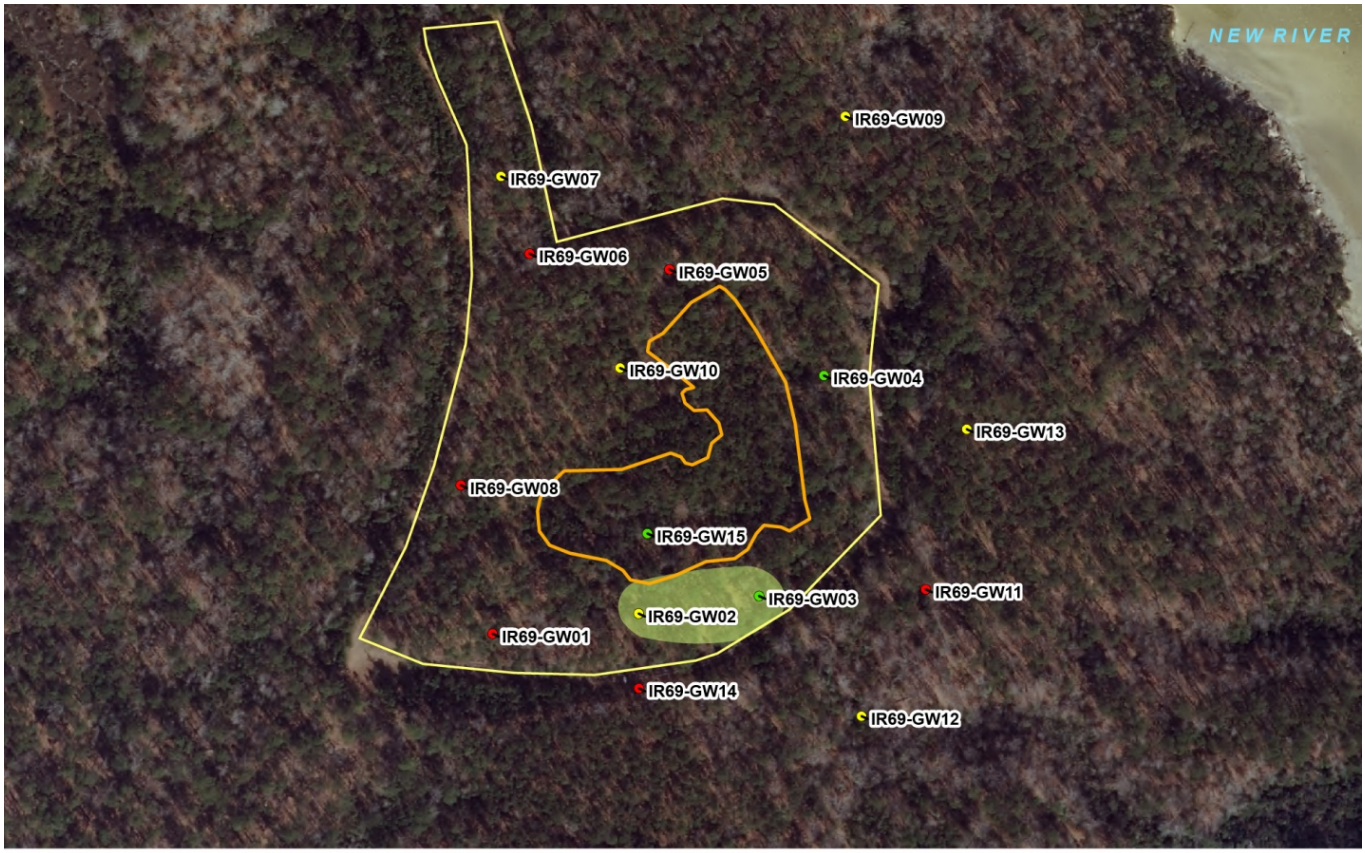
Parameter	Favorable Criteria for Natural Attenuation	Plume Area		Non-Plume Area	
		Measured Range	Frequency Meeting Criteria	Measured Range	Frequency Meeting Criteria
Temperature (°C)	> 20°C	17.07–17.90	0/6	16.33–17.98	0/9
DO (mg/L)	<0.5	0.14 - 1.08	5/6	0.08–0.94	7/9
pH (SU)	5–9	6.75–7.97	6/6	7.35–8.34	9/9
ORP (mV)	<50	-189.4 – -137.3	6/6	-191.0 – -93.4	9/9
Fe(II) (mg/L)	>1	ND–4.2	3/6	ND–2.5	4/9
Sulfide (mg/L)	>1	ND	0/6	ND–0.6 J	0/9
Nitrite (mg/L)	presence	ND–0.165	2/6	ND–0.099	4/9
Methane (µg/L)	>500	3 B–74 BD	0/6**	0.6 B–49 B	0/9**
Chloride (mg/L)	> 2X background (21.2 mg/L)***	6.2–170 D	3/6	4.7–18.1 D	0/9
Alkalinity (mg/L)	> 2X background (202 mg/L)***	61.4–203	1/6	101–219	1/9
Sulfate (mg/L)	<20	ND–37	5/6	ND–370 D	4/9
Nitrate (mg/L)	<1	ND	6/6	ND–8.8	7/9
TOC (mg/L)	> 20	ND–4.3	0/6	0.45 J–3.1	0/9
Ethene (µg/L)	>10	ND–63	1/6	ND–0.2 J	0/9
Ethane (µg/L)	>10	ND–5	0/6	ND–0.2 J	0/9

*Source: USEPA, 1998

** Methane was detected in all samples at concentrations below blank concentrations.

*** Background concentrations were calculated from upgradient well IR69-MW14IW.

FIGURE 7
NAIP Conditions in the Surficial Aquifer



Legend

EPA Score

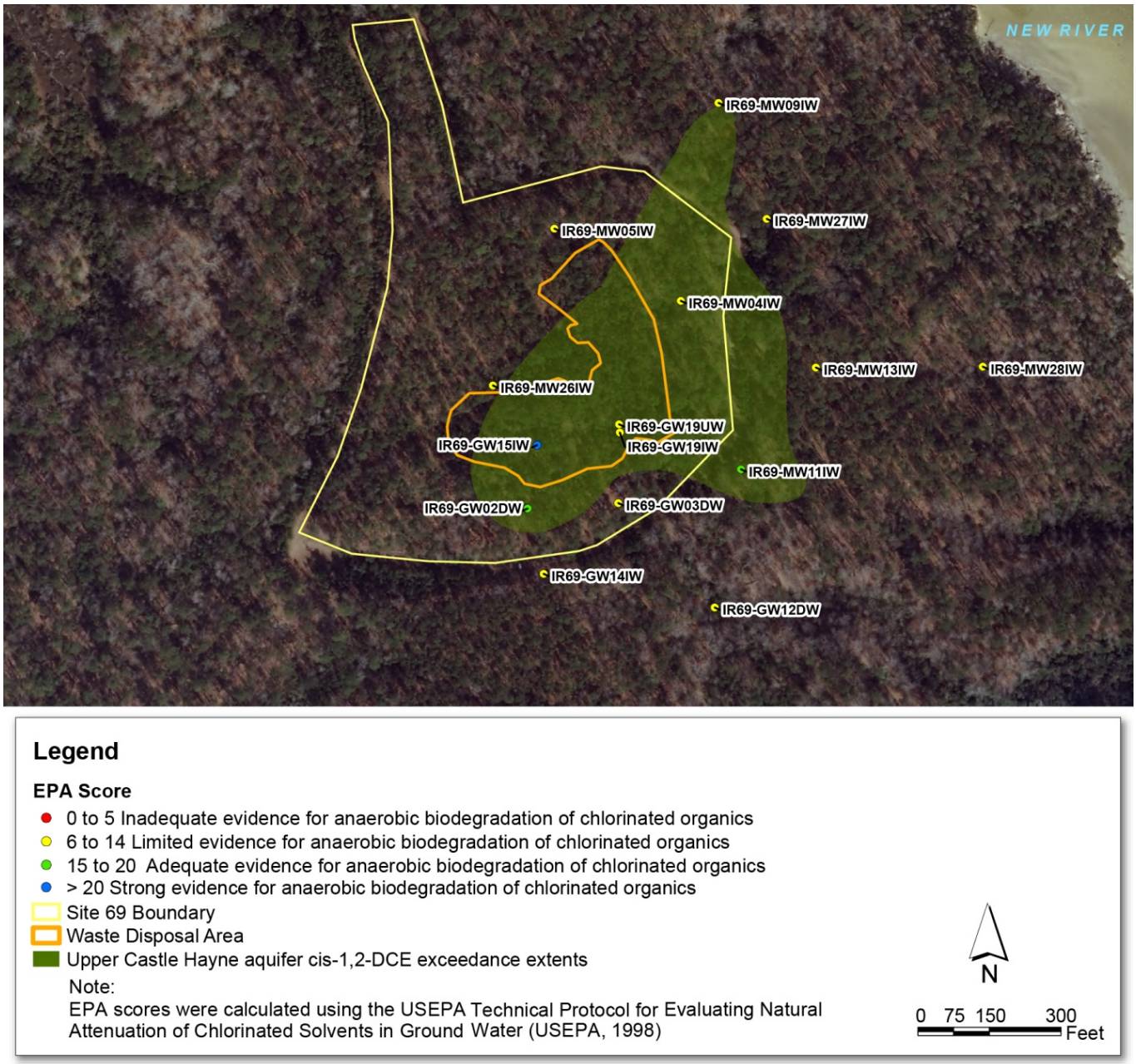
- 0 to 5 Inadequate evidence for anaerobic biodegradation of chlorinated organics
- 6 to 14 Limited evidence for anaerobic biodegradation of chlorinated organics
- 15 to 20 Adequate evidence for anaerobic biodegradation of chlorinated organics
- Site 69 Boundary
- Waste Disposal Area
- Surficial aquifer cis-1,2-DCE exceedance extents

Note:
EPA scores were calculated using the USEPA Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water (USEPA, 1998)

N

0 75 150 300 Feet

FIGURE 8
NAIP Conditions in the Upper Castle Hayne Aquifer



Microcosm Studies

- Microbial analysis conducted in the middle and upper Castle Hayne aquifers indicated the presence of microorganisms that mediate reductive dechlorination of chloroethenes, particularly in IR69-GW15IW and IR69-GW15DW (**Table 7**).

TABLE 7
Microbial Analysis

cells/mL	Upper Castle Hayne Aquifer			Middle Castle Hayne Aquifer	
	IR69-MW11IW	IR69-GW15IW	IR69-MW27IW	IR69-GW15DW	IR69-GW27DW
Dehalococcoides	7.00E-01	3.01E+05	3.20E+00	3.00E-01	1.01E+01
Desulfuromonas	1.00E+00	2.94E+01	ND	7.29E+03	2.57E+01
Dehalobacter	6.50E+00	3.40E+01	4.40E+00	1.69E+01	6.90E+00
Desulfitobacterium	3.21E+05	7.01E+05	4.44E+06	2.73E+05	7.80E+04

Fate and Transport of Contamination

The primary contaminant migration pathway is through groundwater flow in the surficial, upper Castle Hayne, and middle Castle Hayne aquifers. Infiltrating water generally reaches the water table at approximately 4 to 10 ft bgs and enters the surficial aquifer. Groundwater migrates horizontally downgradient toward the New River and vertically into the upper Castle Hayne aquifer. The Castle Hayne confining unit is only semi-confining in the Site 69 area, allowing some downward migration of groundwater. Contaminants are leached from the buried waste material and transported into the underlying aquifers. Groundwater flow in the surficial aquifer is radially outward from the source area and follows the site topography to surface water features to the north, east, and south of the site. Groundwater flow in the upper and middle Castle Hayne aquifer is east and northeast toward the New River. Vertical migration of COCs is evidenced by detected concentrations in samples from downgradient monitoring wells screened in deeper aquifers. There is also a downward vertical gradient between the surficial and Castle Hayne aquifers.

The New River is located downgradient of the eastern boundary of Site 69 and is the ultimate receptor for surface water and groundwater discharge from the site. Surface water and sediment at Site 69 were investigated during the Confirmation Study, RI, and SI. The surface water and sediment investigated as part of Site 69 consist of the drainage areas northeast, east, and southeast of the site. Current (2010) analytical data for surface water indicates that metals (lead, selenium, silver, thallium, and zinc) are present in surface water at concentrations that exceed applicable screening values. The concentrations were generally within one order of magnitude of the most-conservative screening value or background concentration.

SVOCs, pesticides, and PCBs were detected infrequently in groundwater at low concentrations relative to screening values, and are less mobile in the environment than VOCs. Metals may be more mobile in shallow groundwater; however, analytical results indicate that metals exceedances are generally confined to the source area.

Groundwater modeling has shown that the New River will not be impacted at the discharge point. The model predicts that each **plume** (defined as groundwater concentrations exceeding NCGWQS) will remain relatively stable over the 100-year predicted period. This 100-year timeframe is a factor of a continuing source. VC concentrations were predicted to exceed NCGWQS (0.03 µg/L) throughout the aquifer in all future models (2020 to 2110). However, the dissolved-phase (degradation) contaminants are at lower concentrations and will not exceed NCSWQS at discharge. VC concentrations are predicted to remain below NCSWQS (2.4 µg/L) at the discharge point to the New River. Concentrations of TCE and cis-1,2-DCE are not predicted to exceed NCSWQS (30 µ/L for TCE; no criterion was available for cis-1,2-DCE).

2.5 Current and Potential Future Land and Water Uses

Site 69 is a former waste disposal area that is currently restricted from use and enclosed by a fence with a locked access gate. The current land use is expected to remain into the future and LUCs are in place and will be replaced based on the current extent of contamination and maintained to prevent any intrusive activities or development. The site is secluded; however, military training exercises are occasionally conducted in areas outside of the Site 69 fence and access to this area of the Base is strictly controlled with security requirements.

Based on the potential for CA, a Determination of Applicability will be required before implementation of the remedial action. Based on the potential for MEC/MPPEH, the requirements in the Explosives Safety Submission (ESS) (CH2M HILL, dated September 2011) should be followed (e.g., anomaly avoidance) for any activities conducted within the fence.

Potable water for MCIEAST-MCB CAMLEJ and the surrounding residential area is provided by public water supply wells that pump groundwater from the Castle Hayne aquifer. Regionally in southeastern North Carolina, the Castle Hayne aquifer may be used as a potable source of domestic water supply, watering lawns, or filling swimming pools. The closest active **water supply wells** on the Base are located more than 2 miles from Site 69, across the New River.

2.6 Summary of Site Risks

As part of the 2010 Site 69 SI, an HHRA and ERA were conducted to evaluate risks resulting from COCs detected at Site 69. Potential human health risk from exposure to metals in surficial aquifer groundwater and potential ecological risk from pesticides in surface soil and sediment were further evaluated as part of the 2012 UXO-02 Expanded SI. **Table 8** and the following subsections summarize the findings of these risk assessments.

TABLE 8
Site 69 Risk Summary

Media	Human Health Risk	Ecological Risk
Surface/Subsurface Soil Outside of Waste	Acceptable	Acceptable
Waste and Associated Soil	Unacceptable	Unacceptable
Groundwater	Unacceptable	Acceptable*
Sediment	Acceptable	Acceptable
Surface Water	Acceptable	Acceptable
Potential Indoor Air	Unacceptable	Not Applicable

*Groundwater was evaluated assuming it may discharge to surface water.

2.6.1 Human Health Risk Summary

The HHRA was completed as part of the 2010 SI and 2012 Expanded SI for UXO-02 to evaluate the potential impact of COCs on human health now and in the future. Human health risks are assumed to be present as the result of waste materials and associated soil present in the waste disposal area at Site 69; however, LUCs currently prevent any current or future exposure to this area. As a result, these areas were not included in the HHRA. The **exposure scenarios** evaluated included exposure to surface soil outside of the waste disposal area, surface water, and sediment for current **receptors**; and exposure to surface and subsurface soil outside of the waste disposal area, groundwater, surface water, and sediment for future receptors.

Health risks are based on a conservative estimate of the potential **cancer risk** or the potential to cause other health effects not related to cancer (non-cancer hazard, or **hazard index** [HI]). USEPA identifies an acceptable cancer risk range of 1 in 10,000 (10^{-4}) to 1 in 1,000,000 (10^{-6}) and an acceptable non-cancer hazard as an HI of less than 1. **Tables 9** and **10** summarize the potential human health risks. The HHRA concluded the following:

- Because the site is fenced and access is restricted, there is no unacceptable risk to human health based on current site use.
- Risks associated with current and future receptor contact with surface water, sediment, and soils outside the waste disposal area were below USEPA target levels.
- Unacceptable risks from exposure to waste and soil are assumed to be present as result of materials, including potential MEC/MPPEH and CA, present in the disposal trenches and burial pits.
- The future industrial and residential use scenarios indicated there would be an unacceptable risk from exposure to groundwater, including CVOCs, pesticides/PCBs, and metals, in the surficial and upper Castle Hayne aquifers.
- There is a potential risk to future industrial or residential receptors from exposure to CVOCs in indoor air if the vapor intrusion pathway is completed by constructing buildings within Site 69 or within 100 ft of the groundwater plume.

2.6.2 Ecological Risk Summary

The ERA was conducted as part of the 2010 SI to evaluate potential risks to ecological receptors from exposure to soil outside the waste area, surface water, sediment, and groundwater. Potential ecological risk from pesticides in surface soil and sediment was further evaluated as part of the Step 3b refinement completed during the development of the UXO-02 Expanded SI.

Risk was estimated by calculating **hazard quotients** (HQs) using the concentration of each contaminant in applicable media (soil, sediment, surface water, and groundwater) and dividing by an ecological screening value (ESV). Contaminants were retained for further assessment if the HQ was greater than 1 (the concentration exceeded the ESV), the contaminant was detected but did not have an ESV, or the contaminant was not detected but the reporting limit was greater than the ESV. The list of COCs was further refined using a weight-of-evidence approach that considered spatial and temporal distribution of analytical results, the general ecological setting and health of the ecosystems, and food chain modeling.

Based on the ERA, conclusions are as follows:

- Ecological risks are assumed to be present as a result of waste materials and the associated soil present in the disposal trenches and burial pits at Site 69.
- No unacceptable ecological risks were identified from potential exposure to soil, surface water, sediment, or groundwater in areas outside of the disposal trenches and burial pits at Site 69.

2.6.3 Basis for Response Action

Human health and ecological risks are assumed to be present within the waste disposal area at Site 69. Based on the HHRA, exposure to groundwater at Site 69 poses an unacceptable risk to human health. The future use scenario indicated there would be an unacceptable risk from exposure to CVOCs in the surficial aquifer groundwater and CVOCs, pesticides, PCBs, and metals in the upper Castle Hayne aquifer groundwater.

Under **North Carolina's groundwater classification**, the surficial and Castle Hayne aquifers are considered Class GA, a potential source of drinking water. NCDENR identified NCGWQS as "applicable" chemical-specific requirements that are the basis for establishing cleanup levels for groundwater.

It is the current judgment of the Navy, MCIEAST-MCB CAMLEJ, and USEPA, in concurrence with NCDENR, that the Selected Remedy identified in this ROD, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

TABLE 9
Summary of Potential Human Health Risks

Receptor	Media	Pathway	COC	Exposure Point Concentration* (µg/L) for ingestion and dermal contact pathway, mg/m^3 for inhalation pathway)	Reasonable Maximum Exposure (RME) Cancer Risk	RME Non-Cancer Hazard (HI)	Central Tendency Exposure (CTE) Cancer Risk	CTE Non-Cancer Hazard (HI)	Cancer Toxicity Factor (CSF) mg/kg-day^{-1}	Inhalation Unit Risk Factor (IUR) (µg/m^3)$^{-1}$	Reference Dose (RfD) mg/kg-day	Inhalation Reference Concentration (RfC) mg/m^3
Future Adult Resident	Groundwater Surficial Aquifer	Ingestion	cis-1,2-DCE	110	NA	1.6	NA	0.3	NA	NA	2.0×10^{-3}	NA
			Heptachlor epoxide	0.08	NA	0.2	NA	NC	NA	NA	1.3×10^{-5}	NA
			Iron	18,328	NA	0.7	NA	NC	NA	NA	7.0×10^{-1}	NA
			Manganese	800	NA	0.9	NA	NC	NA	NA	2.4×10^{-2}	NA
			Vanadium	22.6	NA	0.1	NA	NC	NA	NA	5.0×10^{-3}	NA
			Zinc	4,595	NA	0.4	NA	NC	NA	NA	3.0×10^{-1}	NA
		Dermal Contact	cis-1,2-DCE	110	NA	0.2	NA	NC	NA	NA	2.0×10^{-3}	NA
			Heptachlor epoxide	0.08	NA	0.3	NA	NC	NA	NA	1.3×10^{-5}	NA
		Inhalation	1,1,2-TCA	0.007	NA	0.9	NA	NC	NA	NA	NA	2.0×10^{-4}
	Groundwater Castle Hayne Aquifer	Ingestion	cis-1,2-DCE	43,000	NA	590	NA	26	NA	NA	2.0×10^{-3}	NA
			trans-1,2-DCE	640	NA	0.9	NA	NC	NA	NA	2.0×10^{-2}	NA
			VC	4,700	NA	43	NA	1.8	NA	NA	3.0×10^{-3}	NA
			Iron	7,569	NA	0.3	NA	NC	NA	NA	7.0×10^{-1}	NA
			Thallium	5.6	NA	15	NA	7.2	NA	NA	1.0×10^{-5}	NA
		Dermal Contact	cis-1,2-DCE	43,000	NA	75	NA	3.1	NA	NA	2.0×10^{-3}	NA
			VC	4,700	NA	2.3	NA	0.09	NA	NA	3.0×10^{-3}	NA
			Heptachlor epoxide	0.05	NA	0.2	NA	NC	NA	NA	1.3×10^{-5}	NA
		Inhalation	1,2,4-TCB	0.01	NA	0.2	NA	NC	NA	NA	NA	2.0×10^{-3}
			trans-1,2-DCE	1.5	NA	0.6	NA	NC	NA	NA	NA	6.0×10^{-2}
			VC	14	NA	3.2	NA	0.04	NA	NA	NA	1.0×10^{-1}
Future Child Resident	Groundwater Surficial Aquifer	Ingestion	cis-1,2-DCE	110	NA	3.7	NA	1.1	NA	NA	2.0×10^{-3}	NA
			VC	13.4	NA	0.3	NA	NC	NA	NA	3.0×10^{-3}	NA
			Heptachlor epoxide	0.08	NA	0.4	NA	0.3	NA	NA	1.3×10^{-5}	NA
			Iron	18,328	NA	1.7	NA	0.6	NA	NA	7.0×10^{-1}	NA
			Manganese	800	NA	2.1	NA	0.4	NA	NA	2.4×10^{-2}	NA
			Vanadium	22.6	NA	0.3	NA	NC	NA	NA	5.0×10^{-3}	NA
			Zinc	4,595	NA	1.0	NA	0.3	NA	NA	3.0×10^{-1}	NA
		Dermal Contact	cis-1,2-DCE	110	NA	0.5	NA	NC	NA	NA	2.0×10^{-3}	NA
			Heptachlor epoxide	0.08	NA	0.6	NA	0.2	NA	NA	1.3×10^{-5}	NA
			Manganese	800	NA	0.4	NA	NC	NA	NA	9.6×10^{-4}	NA
		Inhalation	1,1,2-TCA	0.01	NA	2.1	NA	0.08	NA	NA	NA	2.0×10^{-4}
	Groundwater Castle Hayne Aquifer	Ingestion	1,2-DCA	17.1	NA	0.2	NA	NC	NA	NA	6.0×10^{-3}	NA
			cis-1,2-DCE	43,000	NA	1400	NA	87	NA	NA	2.0×10^{-3}	NA
			trans-1,2-DCE	640	NA	2.0	NA	0.1	NA	NA	2.0×10^{-2}	NA
			VC	4,700	NA	100	NA	6.2	NA	NA	3.0×10^{-3}	NA
			Heptachlor epoxide	0.05	NA	0.3	NA	NC	NA	NA	1.3×10^{-5}	NA
			Chromium	10.5	NA	0.2	NA	NC	NA	NA	3.0×10^{-3}	NA

TABLE 9
Summary of Potential Human Health Risks

Receptor	Media	Pathway	COC	Exposure Point Concentration* (µg/L) for ingestion and dermal contact pathway, mg/m^3 for inhalation pathway)	Reasonable Maximum Exposure (RME) Cancer Risk	RME Non-Cancer Hazard (HI)	Central Tendency Exposure (CTE) Cancer Risk	CTE Non-Cancer Hazard (HI)	Cancer Toxicity Factor (CSF) mg/kg-day^{-1}	Inhalation Unit Risk Factor (IUR) (µg/m^3)$^{-1}$	Reference Dose (RfD) mg/kg-day	Inhalation Reference Concentration (RfC) mg/m^3
			Iron	7,569	NA	0.7	NA	0.3	NA	NA	7.0×10^{-1}	NA
			Thallium	5.6	NA	36	NA	24	NA	NA	1.0×10^{-5}	NA
		Dermal Contact	cis-1,2-DCE	43,000	NA	170	NA	6.1	NA	NA	2.0×10^{-3}	NA
			trans-1,2-DCE	640	NA	0.3	NA	NC	NA	NA	2.0×10^{-2}	NA
			VC	4,700	NA	5.4	NA	0.2	NA	NA	3.0×10^{-3}	NA
			Heptachlor epoxide	0.05	NA	0.4	NA	0.1	NA	NA	1.3×10^{-5}	NA
			Thallium	5.6	NA	0.2	NA	NC	NA	NA	1.0×10^{-5}	NA
		Inhalation	1,2,4-TCB	0.02	NA	0.4	NA	NC	NA	NA	NA	2.0×10^{-3}
			trans-1,2-DCE	2.1	NA	1.4	NA	NC	NA	NA	NA	6.0×10^{-2}
			TCE	0.09	NA	0.4	NA	NC	NA	NA	NA	1.0×10^{-2}
			VC	20	NA	8.0	NA	0.07	NA	NA	NA	1.0×10^{-1}
Future Child/ Adult Resident	Groundwater Surficial Aquifer	Ingestion	1,1,2,2-PCA	5.6	1.7×10^{-5}	NA	2.4×10^{-6}	NA	2.0×10^{-1}	NA	NA	NA
			1,1,2-TCA	4.5	3.9×10^{-6}	NA	NC	NA	5.6×10^{-2}	NA	NA	NA
			1,2-DCA	6.9	9.4×10^{-6}	NA	NC	NA	9.1×10^{-2}	NA	NA	NA
			PCE	0.2	1.5×10^{-6}	NA	NC	NA	5.4×10^{-1}	NA	NA	NA
			VC	13	2.0×10^{-4}	NA	6.3×10^{-5}	NA	7.2×10^{-1}	NA	NA	NA
			alpha-BHC	0.08	7.2×10^{-6}	NA	2.6×10^{-6}	NA	6.3×10^{0}	NA	NA	NA
			Aroclor-1260	1.2	3.6×10^{-5}	NA	1.3×10^{-5}	NA	2.0×10^{0}	NA	NA	NA
			beta-BHC	0.2	5.1×10^{-6}	NA	NC	NA	1.8×10^{0}	NA	NA	NA
			Heptachlor epoxide	0.08	1.1×10^{-5}	NA	3.8×10^{-6}	NA	9.1×10^{0}	NA	NA	NA
		Dermal Contact	1,1,2,2-PCA	5.6	2.1×10^{-6}	NA	NC	NA	2.0×10^{-1}	NA	NA	NA
			VC	13.4	1.1×10^{-5}	NA	2.0×10^{-6}	NA	7.2×10^{-1}	NA	NA	NA
			alpha-BHC	0.08	5.9×10^{-6}	NA	NC	NA	6.3×10^{0}	NA	NA	NA
			beta-BHC	0.2	4.1×10^{-6}	NA	NC	NA	1.8×10^{0}	NA	NA	NA
			Heptachlor epoxide	0.08	1.7×10^{-5}	NA	4.1×10^{-6}	NA	9.1×10^{0}	NA	NA	NA
		Inhalation	1,1,2,2-PCA	0.1	4.8×10^{-6}	NA	NC	NA	NA	5.8×10^{-5}	NA	NA
			1,1,2-TCA	0.2	1.5×10^{-6}	NA	NC	NA	NA	1.6×10^{-5}	NA	NA
			1,2-DCA	0.3	4.7×10^{-6}	NA	NC	NA	NA	2.6×10^{-5}	NA	NA
			VC	0.9	2.2×10^{-6}	NA	NC	NA	NA	4.4×10^{-6}	NA	NA
	Groundwater Castle Hayne Aquifer	Ingestion	1,2,4-TCB	8.5	3.7×10^{-6}	NA	NC	NA	2.9×10^{-2}	NA	NA	NA
			1,2-DCA	17.1	2.3×10^{-5}	NA	NC	NA	9.1×10^{-2}	NA	NA	NA
			Chloroform	4.0	1.8×10^{-6}	NA	NC	NA	3.1×10^{-2}	NA	NA	NA
			TCE	30.1	2.6×10^{-6}	NA	NC	NA	5.9×10^{-3}	NA	NA	NA
			VC	4,688	6.9×10^{-2}	NA	4.3×10^{-3}	NA	7.2×10^{-1}	NA	NA	NA
			Aroclor-1260	0.3	1.0×10^{-5}	NA	3.6×10^{-6}	NA	2.0×10^{0}	NA	NA	NA
			Dieldrin	0.03	6.2×10^{-6}	NA	2.2×10^{-6}	NA	1.6×10^{1}	NA	NA	NA
			Heptachlor epoxide	0.05	7.4×10^{-6}	NA	1.8×10^{-6}	NA	9.1×10^{0}	NA	NA	NA
			Chromium	11	2.4×10^{-4}	NA	1.0×10^{-4}	NA	5.0×10^{-1}	NA	NA	NA

TABLE 9
Summary of Potential Human Health Risks

Receptor	Media	Pathway	COC	Exposure Point Concentration* (µg/L) for ingestion and dermal contact pathway, mg/m^3 for inhalation pathway)	Reasonable Maximum Exposure (RME) Cancer Risk	RME Non-Cancer Hazard (HI)	Central Tendency Exposure (CTE) Cancer Risk	CTE Non-Cancer Hazard (HI)	Cancer Toxicity Factor (CSF) mg/kg-day^{-1}	Inhalation Unit Risk Factor (IUR) (µg/m^3)$^{-1}$	Reference Dose (RfD) mg/kg-day	Inhalation Reference Concentration (RfC) mg/m^3
		Dermal Contact	1,2,4-TCB	8.5	4.8×10^{-6}	NA	NC	NA	2.0×10^{-2}	NA	NA	NA
			VC	4,688	7.2×10^{-5}	NA	5.0×10^{-5}	NA	7.2×10^{-1}	NA	NA	NA
			Dieldrin	0.03	5.4×10^{-6}	NA	NC	NA	16.0×10^{0}	NA	NA	NA
			Heptachlor epoxide	0.05	1.1×10^{-5}	NA	1.9×10^{-6}	NA	9.1×10^{0}	NA	NA	NA
			Chromium	10.5	5.9×10^{-6}	NA	2.4×10^{-6}	NA	1.3×10^{-2}	NA	NA	NA
		Inhalation	1,2-DCA	0.8	1.2×10^{-5}	NA	NC	NA	NA	2.6×10^{-5}	NA	NA
			Chloroform	0.2	2.4×10^{-6}	NA	NC	NA	NA	2.3×10^{-5}	NA	NA
			TCE	1.4	1.6×10^{-6}	NA	NC	NA	NA	2.0×10^{-6}	NA	NA
			VC	312	7.8×10^{-4}	NA	5.0×10^{-6}	NA	NA	4.4×10^{-6}	NA	NA
Future Industrial Worker	Groundwater Castle Hayne Aquifer	Ingestion	1,2-DCA	17.1	5.4×10^{-6}	0.03	NC	NC	9.1×10^{-2}	NA	6.0×10^{-3}	NA
			cis-1,2-DCE	43,289	NA	211	NA	18	NA	NA	2.0×10^{-3}	NA
			trans-1,2-DCE	639.7	NA	0.3	NC	NC	NA	NA	2.0×10^{-2}	NA
			VC	4,688	1.2×10^{-2}	15	3.4×10^{-4}	1.2	7.2×10^{-2}	NA	3.0×10^{-3}	NA
			Aroclor-1260	0.3	2.4×10^{-6}	NA	NC	NC	2.0×10^{0}	NA	NA	NA
			Heptachlor epoxide	0.05	1.7×10^{-6}	0.04	NC	NC	9.1×10^{0}	NA	1.3×10^{-5}	NA
			Chromium	10.5	1.8×10^{-5}	0.03	3.6×10^{-6}	0.02	5.0×10^{-1}	NA	3.0×10^{-3}	NA
			Thallium	5.6	NA	5.5	NA	4.8	NA	NA	1.0×10^{-5}	NA

Notes:
Potential unacceptable risks or hazards are shaded yellow.
* Exposure Point Concentration used for RME calculations.
µg/m^3 = microgram(s) per cubic meter
mg/kg-day = milligram(s) per kilograms per day
NA = Not Applicable
Columns F and H for Future Adult and Child resident: Cancer risks were calculated under Future Child/Adult Resident.
Columns G and I for Future Child/Adult Resident: Non-cancer hazards were calculated under Future Child Resident and Future Adult Resident.
NC = Not Calculated
Columns F through I: RME and CTE risks were not calculated where there were no potential unacceptable RME risks or hazards.
RME and CTE COCs included are based on individual constituents that contribute a non-cancer hazard >0.1 to a cumulative non-cancer HI >1 or a cancer risk >10^{-6} to a cumulative cancer risk >10^{-4}.

TABLE 10
Primary COCs

Receptor	Media	Pathway	COC	Exposure Point Concentration* (µg/L) for ingestion and dermal contact pathway, mg/m^3 for inhalation pathway)	RME Cancer Risk	RME Non-Cancer Hazard (HI)	CTE Cancer Risk	CTE Non-Cancer Hazard (HI)	CSF mg/kg-day^{-1}	IUR (µg/m^3)$^{-1}$	RfD mg/kg-day	Inhalation RfC mg/m^3
Future Adult Resident	Groundwater Surficial Aquifer	Ingestion	cis-1,2-DCE	110	NA	1.6	NA	0.31			2.0×10^{-3}	
	Groundwater Castle Hayne Aquifer	Ingestion	cis-1,2-DCE	43,000	NA	590	NA	26			2.0×10^{-3}	
			VC	4,700	NA	43	NA	1.8			3.0×10^{-3}	
			Thallium	5.6	NA	15	NA	7.2			1.0×10^{-5}	
		Dermal Contact	cis-1,2-DCE	43,000	NA	75	NA	3.1			2.0×10^{-3}	
			VC	4,700	NA	2.3	NA	0.09			3.0×10^{-3}	
		Inhalation	VC	14	NA	3.2	NA	0.04			NA	1.0×10^{-1}
Future Child Resident	Groundwater Surficial Aquifer	Ingestion	cis-1,2-DCE	110	NA	3.7	NA	1.1			2.0×10^{-3}	
			Iron	18,328	NA	1.7	NA	0.6			7.0×10^{-1}	
			Manganese	800	NA	2.1	NA	0.4			2.4×10^{-2}	
		Inhalation	1,1,2-TCA	0.01	NA	2.1	NA	0.08			NA	2.0×10^{-4}
	Groundwater Castle Hayne Aquifer	Ingestion	cis-1,2-DCE	43,000	NA	1400	NA	87			2.0×10^{-3}	
			trans-1,2-DCE	640	NA	2.0	NA	0.13			2.0×10^{-2}	
			VC	4,700	NA	100	NA	6.2			3.0×10^{-3}	
			Thallium	5.6	NA	36	NA	24			1.0×10^{-5}	
		Dermal Contact	cis-1,2-DCE	43,000	NA	170	NA	6.1			2.0×10^{-3}	
			VC	4,700	NA	5.4	NA	0.18			3.0×10^{-3}	
		Inhalation	VC	20	NA	8.0	NA	0.07			NA	1.0×10^{-1}
Future Child/Adult Resident	Groundwater Surficial Aquifer	Ingestion	VC	13	2.0×10^{-4}	NA	6.3×10^{-5}	NA	7.2×10^{-1}		NA	
	Groundwater Castle Hayne Aquifer	Ingestion	VC	4,688	6.9×10^{-2}	NA	4.3×10^{-3}	NA	7.2×10^{-1}		NA	
			Chromium	11	2.4×10^{-4}	NA	1.0×10^{-4}	NA	5.0×10^{-1}		NA	
		Inhalation	VC	312	7.8×10^{-4}	NA	5.0×10^{-6}	NA		4.4×10^{-6}	NA	
Future Industrial Worker	Groundwater Castle Hayne Aquifer	Ingestion	cis-1,2-DCE	43,289	NA	211	NA	18			2.0×10^{-3}	
			VC	4,688	1.2×10^{-2}	15	3.4×10^{-4}	1.2	7.2×10^{-1}		3.0×10^{-3}	
			Thallium	5.6	NA	5.5	NA	4.8			1.0×10^{-5}	

Notes:
Potential unacceptable risks or hazards are shaded yellow.
* Exposure Point Concentration used for RME calculations.
NA = Not Applicable
Columns F and H for Future Adult and Child resident: Cancer risks were calculated under Future Child/Adult Resident.
Columns G and I for Future Child/Adult Resident: Non-cancer hazards were calculated under Future Child Resident and Future Adult Resident.
The primary COCs driving unacceptable risk are based on individual constituents with cancer risks >1 x 10^{-4} and non-cancer hazards >1.

The concentrations of COCs in groundwater requiring a response action are summarized in **Table 11**. The location of the waste disposal area and extent of COC groundwater impacts is shown on **Figures 2 through 4**.

TABLE 11
COCs Requiring a Response Action

COC	Maximum Concentration (µg/L)	Location of Maximum Concentration	Frequency Of Detection	NCGWQS (µg/L)	MCL (µg/L)
Metals					
Chromium[1]	21.5	IR69-GW11DW	24/44	10	100
Thallium[1]	5.6 J	IR69-MW28IW	1/44	NS	2
Pesticides/PCBs					
Alpha-BHC[3]	0.077	IR69-GW03	1/44	0.02	NS
Aroclor-1260[3]	1.2	IR69-GW15	2/44	NS	0.5
Dieldrin[3]	0.026 J	IR69-GW15DW	1/44	0.002	NS
Heptachlor epoxide[3]	0.12 J	IR69-GW15IW	3/44	0.004	0.2
VOCs					
1,1,2,2-PCA[3]	9.8	IR69-GW02	4/49	0.2	NS
1,1,2-TCA[2]	7.8	IR69-GW02	3/49	NS	5
1,2-DCA[3]	19	IR69-GW15IW	9/49	0.4	5
cis-1,2-DCE[1]	51,000	IR69-GW15IW	22/49	70	70
TCE[3]	100 J	IR69-GW15IW	13/49	3	5
trans-1,2-DCE[2]	750	IR69-GW15IW	16/49	100	100
VC[1]	5,500	IR69-GW15IW	14/49	0.03	2
Other					
CA*	ND	ND	ND	NS	NS

Notes:
[1] Human health risk based on RME and CTE
[2] Human health risk based on RME
[3] Human health risk based on RME <1 / $<10^{-4}$
*CA is an assumed potential COC, indicated by absence or presence
MCL = Maximum Containment Level
ND = not detected
NS = no standard

2.7 Principal Threat Wastes

"Principal threat wastes" are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should they be exposed. As described in USEPA's *Guide to Principal Threat and Low-level Threat Waste* (EPA OSWER Pub.9380.3-06FS, Nov. 1991), liquids (e.g., in buried drums), non–aqueous phase liquid (NAPL), and/or high concentrations of toxic compounds in soils are considered PTW.

Contaminated groundwater generally is not considered to be a source material; however, NAPLs in groundwater may be viewed as a source material. Dissolved concentrations of COCs in groundwater at approximately 1 to 5 percent of a compound's solubility could suggest the presence of DNAPL in the subsurface. The maximum

concentration of cis-1,2-DCE in the upper Castle Hayne aquifer was identified at approximately 1.5 percent of the compounds' solubility, suggesting that DNAPL may be present within or below the waste disposal area.

Other PTWs include buried waste and potentially contaminated soils that are a source of groundwater contamination. Additionally, the waste in place includes the potential presence of CA. CA is considered a PTW because it is highly toxic and potentially fatal should exposure occur.

In 1993, USEPA established source containment as the **presumptive remedy** for municipal landfills regulated under CERCLA. USEPA guidance developed in 1996 indicated that military landfills regulated under CERCLA should also consider the source containment presumptive remedy approach. However, as detailed in the NCP at 40 CFR 300.430(a)(1)(iii), USEPA expects to use active treatment to address the principal waste threats posed by a site, wherever practicable.

The potential presence of CA material within the buried waste deems removal or treatment to be impractical and/or the costs extraordinarily high. There is also a high risk associated with removal and transportation of CA and limited acceptable disposal facilities. Although technologies are available to treat the DNAPL source, the potential CA material is expected to remain in-place as a continuing source, there are unknown risks associated with chemical reactions of any injected materials with the CA, and there is uncertainty of the ability for subsurface injections to distribute reagents uniformly at acceptable quantities.

2.8 Remedial Action Objectives

Based on the evaluation of site conditions, an understanding of the contaminants, the physical properties in media of concern, the results of risk assessments, current and potential future land use, and an analysis of applicable or relevant and appropriate requirements (ARARs), the following Remedial Action Objectives (RAOs) were established for Site 69:

1. Restore groundwater quality to meet NCDENR and federal primary drinking water standards based on the classification of the aquifer as a potential source of drinking water (Class GA or Class GSA) under 15A North Carolina Administrative Code (NCAC) 02L.0201
2. Minimize exposure to potential CA and chemical waste to the maximum extent practicable
3. Reduce infiltration and leaching of contaminants from waste into groundwater to the maximum extent practicable
4. Prevent exposure to buried waste and associated soil and groundwater until concentrations meet levels that allow for unlimited use and unrestricted exposure
5. Minimize potential degradation of the New River by COC-affected groundwater

Cleanup levels were developed for groundwater COCs contributing to unacceptable risks and hazards from exposure to groundwater at Site 69; see **Table 12**. The cleanup levels for COCs are based upon chemical-specific ARARs, and are the more stringent of the NCGWQS or federal MCL.

TABLE 12
Groundwater Cleanup Levels

COC	NCGWQS (µg/L)	MCL (µg/L)	Cleanup Level
Metals			
Chromium	10	100	10
Thallium	NS	2	2
Pesticides/PCBs			
Alpha-BHC	0.02	NS	0.02
Aroclor-1260	NS	0.5	0.5
Dieldrin	0.002	NS	0.002
Heptachlor epoxide	0.004	0.2	0.004
VOCs			
1,1,2,2-PCA	0.2	NS	0.2
1,1,2-TCA	NS	5	5
1,2-DCA	0.4	5	0.4
cis-1,2-DCE	70	70	70
TCE	3	5	3
trans-1,2-DCE	100	100	100
VC	0.03	2	0.03
Other			
CA*	NS	NS	NS

Notes:
*CA is an assumed potential COC and will be monitored as an indicator of a release from the waste disposal area
NS = no standard

2.9 Description and Comparative Analysis of Remedial Alternatives

2.9.1 Description of Remedial Alternatives

The remedial alternatives that were developed and evaluated to address the waste disposal area and associated soil and groundwater contamination at Site 69 are detailed in the FS. Based on an initial **screening of technologies**, four remedial alternatives were retained for the waste disposal area and five remedial alternatives were retained for groundwater. A detailed comparative analysis was conducted for each alternative. A description is provided in **Tables 13 and 14**.

TABLE 13
Description of Remedial Alternatives – Waste Disposal Area

Alternative	Components	Details	Cost	
1 – No Action	None	None	Total Cost	$0
			Timeframe	Indefinite
2 – LUCs	LUCs	LUCs to prevent exposure to waste and associated soil within the waste disposal area	Capital cost	$13,500
			Total O&M cost	$32,500
			Total present value cost	$46,000
			Timeframe	30 years
3 – Capping	Cap	Construction of a multilayer cap to contain and immobilize contaminants and provide a barrier to receptors	Capital cost	$4,992,000
			Total O&M cost	$521,000
			Total present value cost	$5,513,000
			Timeframe	30 years
	LUCs	LUCs to prevent exposure to waste and associated soil within the waste disposal area		
	MNA/LTM	Monitor performance of cap by sampling downgradient groundwater (performance monitoring is included as part of the MNA/LTM groundwater alternative below)		
4 – Removal	Excavation and Disposal	Removal of the buried waste and associated soil from the waste disposal area and disposal of the materials at an approved facility	Capital cost	$24,502,000
			Total present value cost	$24,502,000
			Timeframe	1 year

TABLE 14
Description of Remedial Alternatives–Groundwater

Alternative	Components	Details	Cost	
1 – No Action	None	None	Total Cost	$0
			Timeframe	Indefinite
2 – MNA/LTM	MNA/LTM	MNA/LTM and reporting to evaluate the following: - Progress of natural attenuation over time, analyzing CVOCs annually and NAIPs every 5 years - LTM of site-specific pesticides, PCBs, metals, and CA every 5 years to monitor concentrations over time, migration, and potential releases	Capital cost	$22,000
			Total O&M cost	$935,000
	LUCs	LUCs to prevent aquifer use and exposure to groundwater	Total present value cost	$957,000
			Timeframe	30 years
3 – PRB	PRB	Installation of a PRB constructed with zero valent iron (ZVI) to promote biodegradation through physical, chemical, or biological processes	Capital cost	$5,100,000
	Performance monitoring	Semiannual groundwater monitoring for first 3 years to evaluate effectiveness of barrier	Total O&M cost	$1,104,000
	MNA/LTM	MNA/LTM and reporting to evaluate the following: - Continued effectiveness of the PRB - Progress of natural attenuation over time, analyzing CVOCs annually and NAIPs every 5 years - LTM of site-specific pesticides, PCBs, metals, and CA every 5 years to monitor concentrations over time, migration, and potential releases - Potential migration to the deep aquifer	Total present value cost	$6,204,000
			Timeframe	30 years
	LUCs	LUCs to prevent aquifer use and exposure to groundwater		
4 – ERD	Enhanced bioremediation	Injection of electron source and substrate and bioaugmentation culture to promote anaerobic biodegradation of VOCs by reductive dechlorination	Capital cost	$1,526,000[a] $3,735,000[b]
			Total O&M cost	$1,104,000
			Total present value cost	$2,630,000[a] $4,839,000[b]
	Performance monitoring	Semi-annual groundwater monitoring for first 3 years to evaluate effectiveness of injections	Timeframe	30 years
	MNA/LTM	MNA/LTM and reporting to evaluate the following: - Continued effectiveness of the ERD injections - Progress of natural attenuation over time, analyzing CVOCs annually and NAIPs every 5 years - LTM of site-specific pesticides, PCBs, metals, and CA every five years to monitor concentrations over time, migration, and potential releases - Potential migration to the deep aquifer		
	LUCs	LUCs to prevent aquifer use and exposure to groundwater		

TABLE 14
Description of Remedial Alternatives–Groundwater

Alternative	Components	Details	Cost	
5 – ISCO	Chemical oxidation of VOCs	Injection of chemical oxidant to chemically degrade VOCs	Capital Cost	$6,509,000
	Performance monitoring	Semi-annual groundwater monitoring for first 3 years to evaluate effectiveness of injections	Total O&M cost	$1,104,000
	MNA/LTM	MNA/LTM and reporting to evaluate the following: - Continued effectiveness of the ISCO injections - Progress of natural attenuation over time, analyzing CVOCs annually and NAIPs every 5 years - LTM of site-specific pesticides, PCBs, metals, and CA every five years to monitor concentrations over time, migration, and potential releases - Potential migration to the deep aquifer		
	LUCs	LUCs to prevent aquifer use and exposure to groundwater		
			Total present value cost	$7,613,000
			Timeframe	30 years

Includes a 4.5 percent discount rate
[a] Vertical Injection/Extraction Wells
[b] Horizontal Injection Wells

2.9.2 Comparative Analysis of Alternatives

A comparative analysis using the **nine USEPA criteria** was completed and is provided as follows. The analyses are summarized in **Tables 15 and 16** for the waste disposal area and groundwater, respectively. The waste disposal area and groundwater No Action alternatives do not meet the RAOs and were not considered further.

TABLE 15
Waste Disposal Area

CERCLA Criteria	No Action (1)	LUCs (2)	Capping (3)	Removal (4)
Threshold Criteria				
Protection of human health and the environment	❍	❍	●	●
Compliance with ARARs	❍	❍	●	●
Primary Balancing Criteria				
Long-term effectiveness and permanence	❍	⭘	⭘	●
Reduction in toxicity, mobility, or volume through treatment	❍	❍	❍	❍
Short-term effectiveness	❍	⭘	⭘	❍
Implementability	●	●	●	❍
Present cost	$0	$46 K	$5.5 M	$24.5 M
Modifying Criteria				
State acceptance	❍	●	●	●
Community acceptance	❍	●	●	●

Ranking: ● High ⭘ Moderate ❍ Low
Rankings are provided as qualitative descriptions of the relative compliance of each alternative with the criteria.

TABLE 16
Groundwater

CERCLA Criteria	No Action (1)	MNA/LTM (2)	PRB (3)	ERD – Injection and Extraction (4a)	ERD – Horizontal (4b)	ISCO (5)
Threshold Criteria						
Protection of human health and the environment	❍	●	●	●	●	●
Compliance with ARARs	❍	●	●	●	●	●
Primary Balancing Criteria						
Long-term effectiveness and permanence	❍	◉	●	◉	◉	◉
Reduction in toxicity, mobility, or volume through treatment	❍	❍	◉	◉	◉	◉
Short-term effectiveness	❍	◉	◉	❍	◉	❍
Implementability	●	●	◉	❍	◉	◉
Present cost	$0	$1 M	$6.2 M	$2.6 M	$4.8 M	$7.6 M
Modifying Criteria						
State acceptance	❍	●	●	●	●	●
Community acceptance	❍	●	●	●	●	●

Ranking: ● High ◉ Moderate ❍ Low

Rankings are provided as qualitative descriptions of the relative compliance of each alternative with the criteria.

Threshold Criteria

Overall Protection of Human Health and the Environment

Waste Disposal Area

Alternative 2 (LUCs) would not be protective of ecological receptors and is not considered further. Alternatives 3 (Capping) and 4 (Removal) are suitable for addressing buried waste and associated soil for the reduction of risk to human and ecological risk receptors. They also provide an active approach to meet the RAOs. Alternative 3 is the most protective of human health and the environment in the short-term, as it controls the exposure to the buried waste and minimizes leaching of contaminants to groundwater. However, Alternative 4 is the most protective of human health and the environment in the long-term as the source would no longer be present.

Capping is the presumptive remedy for landfill sites, except that when PTWs are present, USEPA expects treatment or removal of such source materials to the maximum extent possible. Alternative 3 (Capping) does not meet USEPA's preference for treatment or removal but does provide a cover that minimizes infiltration and resulting contaminant leaching to groundwater. While Alternative 4 (Removal) meets USEPA's preference for the removal of the PTW, the risk associated with the removal and disposal of CA is high due to the lethal toxicity of these contaminants.

Groundwater

Alternatives 2 through 5 (MNA/LTM, PRB, ERD, and ISCO, respectively, with LUCs) are protective and will result in the reduction of risk to human and ecological risk receptors. Alternatives 3, 4, and 5 provide active treatment. However, no alternative will permanently reduce the risks as long as the contaminant source area remains intact. Monitoring and LUCs will provide protection until RAOs are achieved.

Compliance with ARARs

Section 121(d) of CERCLA, as amended, specifies in part, that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more-stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., **ARARs**) to the hazardous substances or particular circumstances at a site unless such ARAR(s) are waived under CERCLA Section 121(d) (4). *See also* 40 CFR 300.430(f)(1)(ii)(B). The ARARs for Site 69 are provided in **Appendix A** as Tables A-1, A-2, and A-3.

Waste Disposal Area

Alternatives 3 (Capping) and 4 (Removal) are expected to meet ARARs. No Action (Alternative 1) and LUCs (Alternative 2) would not meet the location-specific ARARs related to sensitive ecosystems.

Location- and action-specific ARARs regarding land-disturbing activities and waste disposal during capping (Alternative 3) or removal activities (Alternative 4) would be complied with during implementation of each remedy. Alternative 3 (Capping) would also comply with the action-specific ARARs for a RCRA Subtitle C landfill to minimize infiltration through the buried waste (source materials, which would be RCRA hazardous waste, and resulting contaminant leaching to groundwater.

Groundwater

All groundwater alternatives, except the No Action alternative, are expected to meet ARARs. Action-specific ARARs specific to Alternatives 3 (PRB), 4 (ERD), and 5 (ISCO) regarding land-disturbing activities and waste handling would be complied with during the implementation of the alternative. MNA and LTM will be conducted, as part of all alternatives except No Action, to evaluate compliance with the location-specific ARARs regarding discharge of groundwater to wetlands or water bodies. LUCs will be updated and maintained to prevent exposure to groundwater until such time that the chemical-specific ARARs, including NCGWQS and federal MCLs, can be achieved.

Primary Balancing Criteria

Long-term Effectiveness and Permanence

Waste Disposal Area

Alternatives 3 (Capping) and 4 (Removal) are expected to be effective at reducing impacts of COCs in the long term. Alternative 3 (Capping) is considered to meet permanence goals by maintaining LUCs over time when paired with a groundwater alternative. Alternative 4 (Removal) would be a permanent remedy by effectively removing the source.

Groundwater

Alternatives 2 through 5 (MNA/LTM, PRB, ERD, and ISCO, respectively) are expected to be effective in the long term, although "**rebound**" is a potential issue with the injection scenarios. Active treatment is intended to treat the area of the plume with the highest concentrations of COCs and allow natural attenuation to reduce groundwater contaminant concentrations, reducing migration toward the New River. Alternative 2 would take the longest time to achieve RAOs without active treatment. Alternative 3 would take the longest time of the active treatment alternatives because it relies on the plume to flow through the PRB, but it is protective for downgradient receptors. Alternative 4 relies on biological degradation rather than chemical or physical processes to remove contaminant mass, taking longer than Alternative 5, which would likely remove COCs in the shortest amount of time. Distribution and rebound may hinder the effectiveness of ERD and ISCO.

Reviews at least every 5 years, as required, would be necessary to evaluate the effectiveness of any of the alternatives because hazardous substances would remain onsite at concentrations above levels that allow for unlimited use and unrestricted exposure.

Reduction of Toxicity, Mobility, or Volume through Treatment

CERCLA Section 121(b) (1) and NCP requirement as referenced at 40 CFR 300.430(f)(1)(ii)(E) and 300.430(f)(5)(ii)(F) indicate that PTWs should be treated to the maximum extent practical. Based on the unique nature of the CA potentially present in the waste disposal area, treatment is not feasible and none of the remedial alternatives include treatment. The CA that is reportedly disposed of has not been located because of the limitations on intrusive investigation into the waste disposal area, and it has not been detected in the environmental samples (i.e., soil, groundwater, surface water, etc.).

For the waste disposal area and associated soil, leaving the potentially buried CA in the ground may be preferable to excavation and destruction per the *Programmatic Environmental Impact Statement: Destruction of Non-Stockpile Chemical Warfare Materiel Containing Chemical Agent* (FR. Oct. 18, 1996 [Volume 61, Number 203]). Technologies are available to treat the DNAPL source; however, with the potential CA material, treatment options are limited as ex-situ remediation is impractical and there are unknown risks associated with chemical reactions of any injected materials with the CA. If investigation or treatment technologies are discovered that promote feasibility of further investigation and remediation of CA, a more conclusive search for potential CA will be considered in the Five-Year Review.

Waste Disposal Area

Alternative 3 (Capping) does not include treatment of wastes or associated soil that are considered PTW and does not reduce toxicity or volume. However, Alternative 3 (Capping) would reduce mobility through minimized infiltration, preventing leaching of COCs into subsurface soils and groundwater. Alternative 4 (Removal) also does not include treatment but would remove the PTW, which reduces toxicity and volume as well as the mobility.

Groundwater

Alternatives 3 (PRB), 4 (ERD), and 5 (ISCO) include treatment. Alternative 5 (ISCO) is expected to reduce toxicity and volume of the plume within the fastest timeframe. With Alternative 4 (ERD), toxicity, mobility, and volume will be reduced at a relatively slower rate. Toxicity, mobility, and volume will be reduced outside of the source area with Alternative 3 (PRB) as the plume migrates. However, no alternative will permanently reduce the risks as long as the contaminant source area remains intact. Although Alternative 2 (MNA/LTM) does not include treatment and would take the longest, it provides reduction in toxicity, mobility, or volume under natural processes. Previous treatability studies, as detailed in **Table 1**, were not effective in treating the source area, which may indicate that treatment is not practicable for treating the potential DNAPL.

Short-term Effectiveness.

Waste Disposal Area

Alternatives 3 (Capping) and 4 (Removal) pose an elevated risk to workers through the use of heavy equipment and significant soil movement. Alternative 4 would also pose potential risk of exposure to CA, if present, through offsite waste transportation and disposal. These risks would be minimized through the use of safety controls, appropriate personal protective equipment (PPE), and air monitoring. The duration of short-term exposure risk associated with implementing Alternative 3 (Capping) is expected to be approximately 5 months. Alternative 4 (Removal) would present the greatest short-term risk to workers and the community near the disposal transportation route and the environment due to the nature of materials potentially disposed of at the site; however, it also would exhibit the shortest remediation timeline while effectively addressing the source. The duration of short-term exposure risk associated with implementing Alternative 4 (Removal) is expected to be approximately 6 months.

The generation of greenhouse gasses and criteria pollutants are the highest for the Alternative 4 (Removal), followed by Alternative 3 (Capping), and are mostly a result of the amount of construction activities required to implement each of the alternatives. Similarly, Alternative 4 (Removal) has the highest energy and water usage, followed by Alternative 3 (Capping), which is also related to the amount of construction activities.

Groundwater

Short-term effectiveness in terms of risks to workers, the community, and the environment is minimized for Alternatives 2 through 5 (MNA/LTM, PRB, ERD, and ISCO, respectively) through the use of appropriate PPE and air monitoring. The duration of short-term exposure risk associated with implementing Alternatives 3 through 5 ranges from approximately 100 days for Alternative 3 (PRB) to 3 years for Alternative 4 (ERD). The duration of short-term exposure risk for Alternative 5 (ISCO) is 2 years, but has a higher short-term risk because of the use of chemical oxidants.

Alternatives 4 (ERD) and 5 (ISCO) are most likely to achieve RAOs in the shortest period of time because of enhanced distribution of relatively fast-acting reagents, particularly chemical oxidation. Subsurface distribution is key to the effectiveness and treatment timeframe of Alternatives 4 (ERD) and 5 (ISCO) (microbes, ERD substrate, or oxidant). The timeframe associated with complete dechlorination via bioremediation can be many years. Alternative 2 (MNA/LTM) would likely exhibit the least short-term effectiveness for the remediation timeline because it would be dictated by the rate of natural biodegradation, and Alternative 3 (PRB) would be limited because it relies on groundwater to flow through the PRB as it migrates toward the New River.

Alternative 2 (MNA/LTM) has the lowest relative environmental footprint of the groundwater alternatives, while the environmental footprint of Alternative 3 (PRB) is highest, primarily due to the equipment use and consumables (ZVI) associated with construction of the PRB. The next-highest overall environmental footprint would be from Alternative 5 (ISCO), which had the highest relative water use, driven by water requirements during injections, followed by Alternative 4 (ERD), which had slightly lower overall environmental impacts.

Implementability

Waste Disposal Area

Alternative 3 (Capping) is implementable, with materials and services readily available. Alternative 4 (Removal) would be difficult to implement because of the potential presence of CA at the site. If present, management of CA will be difficult, disposal options are limited at this time, additional health and safety precautions would be required, and the U.S. Army would become the lead agency for dealing with the CA.

Groundwater

Each alternative is implementable, with materials and services readily available. However, subsurface injections rely heavily on the ability to distribute reagents uniformly at acceptable quantities. In Alternative 4 (ERD), injection through vertical injection and extraction wells (Alternative 4a) would be more difficult to implement than injection through horizontal wells (Alternative 4b). Furthermore, Alternative 3, implementation of a trenchless PRB, would be easier than injections through horizontal wells, although ensuring a continuous barrier is technically challenging. Alternative 5 (ISCO) would require extra health and safety precautions for the handling of the oxidant. Alternatives 4 (ERD) and 5 (ISCO) would involve installation of 20 injection and extraction wells or 5,600 linear ft of horizontal wells.

Cost

Tables 13 and 14 summarize the capital costs, as well as long-term O&M costs (as applicable) for the alternatives. For comparative purposes, a 30-year timeframe with a 4.5 percent discount rate was used for groundwater alternatives.

Waste Disposal Area

The estimated present-worth cost of Alternative 3 (Capping) is $5,513,000, which is approximately 20 percent of the cost of Alternative 4 (Removal), estimated at $24,502,000.

Groundwater

The estimated present-worth cost of Alternative 2 (MNA/LTM) is $957,000. The estimated present-worth cost of Alternative 3 (PRB) is $6,204,000, which is more than two times the cost of Alternative 4a (ERD with vertical wells) at $2,630,000 and approximately 20 percent more than Alternative 4b (ERD with horizontal wells) at $4,840,000. Alternative 5 (ISCO), estimated at $7,613,000, is the most expensive of the groundwater alternatives.

Modifying Criteria

State Acceptance

State involvement has been solicited throughout the CERCLA process. NCDENR, as the designated state support agency in North Carolina, concurs with the Selected Remedy.

Community Acceptance

The public meeting was held on August 16, 2012, to present the Proposed Remedial Action Plan (PRAP) and answer community questions regarding the proposed remedial action at Site 69. The questions and concerns raised at the meeting were general inquiries for informational purposes only. No comments requiring amendment to the PRAP were received from the public during the meeting and public comment period.

2.10 Selected Remedy

Alternative 3, capping with LUCs, for the waste disposal area and Alternative 2, MNA and LTM with LUCs, for groundwater comprise the Selected Remedy for Site 69.

2.10.1 Rationale for the Selected Remedy

For the waste disposal area, Alternative 3 was preferred over Alternative 4 (Removal) because of the additional health and safety risks, cost, and implementation challenges associated with excavation and disposal of waste material potentially including CA. While capping does not meet USEPA's preference for active treatment, it does provide containment, a USEPA acceptable alternative to reduce the mobility of the PTW. The high risk associated with removal and transportation of CA and the limited acceptable disposal facilities for CA waste make the USEPA preference for removal of the PTW an impractical alternative at this time.

For groundwater, it is expected that the selected remedy for the waste disposal area will significantly reduce infiltration rates that will minimize continued source area leaching to groundwater. Technologies are available to treat the DNAPL source; however, with the potential CA material, ex-situ remediation is impractical and there are unknown risks associated with chemical reactions of any injected materials with the CA. Therefore, Alternative 2 (MNA) was preferred over Alternatives 3 (PRB), 4 (ERD), and 5 (ISCO) because it is as protective of human health and the environment, easier to implement, and has lower associated costs. The cost of implementing Alternative 3 would be much higher while containment, or reduction of mobility, is being addressed with the selected waste disposal area alternative. Alternative 2 was preferred over Alternatives 4 and 5 because the contaminant source area remains in place, the uncertainty of the ability for subsurface injections to distribute reagents uniformly at acceptable quantities, and due to the potential presence of reactive chemicals in the landfill that could cause explosions or other reactions if chemicals are injected into the source area.

The ultimate objective for groundwater is to restore groundwater quality to its beneficial uses. Based on information obtained during previous investigations and a careful analysis of all remedial alternatives MNA is an acceptable alternative to achieve this objective. Per USEPA guidance, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, clear and meaningful trends of decreasing contaminant mass have been documented, hydrogeologic and geochemical data demonstrate active natural attenuation processes at the site, and microcosm studies indicate the presence of favorable microorganisms at the site. Site-specific lines of evidence for MNA are presented in Section 2.4 and are summarized below.

- Historical data trends show an overall decrease in TCE and DCE and an increase in VC, which is strongly supportive of reductive dechlorination.
- Within the area of contamination, groundwater is reduced and DO concentrations are favorable for reductive dechlorination.
- The presence of ferrous iron and elevated alkalinity levels are suggestive of biological activity.

- Microbial analysis conducted in the upper and middle Castle Hayne aquifers indicated the presence of microorganisms that mediate reductive dechlorination of chloroethenes, particularly in the most contaminated areas.
- Surface water samples collected adjacent to Site 69 indicated that NCSWQS are not currently being exceeded and modeling predicts that the groundwater plume will remain relatively stable and will remain below NCSWQS at the discharge point to the New River.

LUCs will be updated and maintained to prevent exposure to buried waste and associated soil and groundwater.

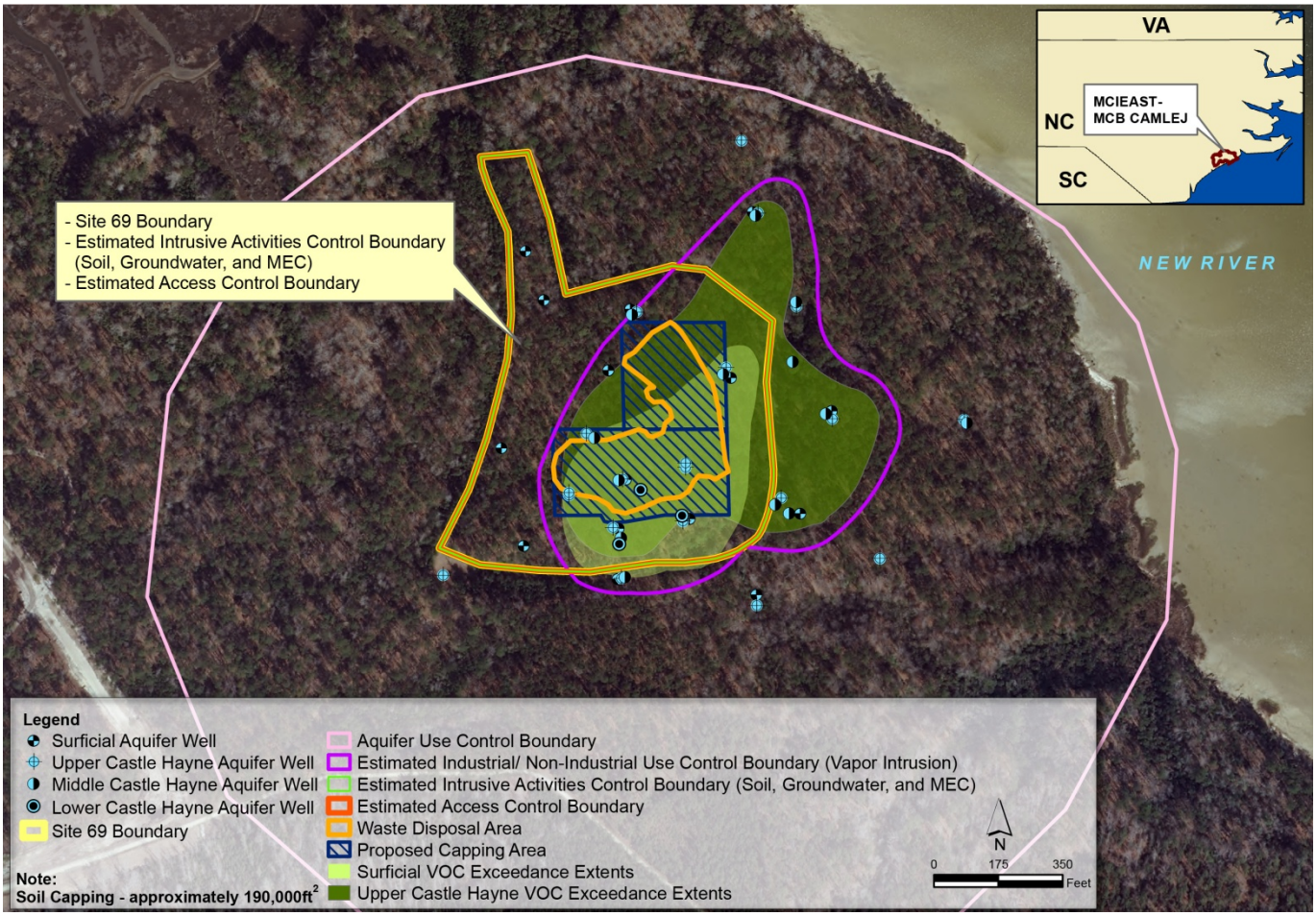
2.10.2 Description of the Selected Remedy

The Selected Remedy for Site 69 includes the following:

- Capping to prevent potential exposure to buried wastes and contaminated soil (some of which are considered PTW) and provide a barrier for potential receptors and infiltration
- MNA and LTM to monitor groundwater and track changes in COC concentrations and NAIPs
- LUCs to protect receptors from potential contact with buried waste and associated soils, and prevent aquifer use
- O&M to maintain the cap and LUCs

The proposed capping area, monitoring well network, and LUC boundaries are shown on **Figure 9**.

FIGURE 9
Selected Remedy



A multilayer cap with an impermeable layer meeting relevant RCRA Subtitle C landfill cover requirements will be installed to minimize infiltration and resulting contaminant leaching to groundwater. The cap will be constructed over the southern and eastern burial trenches as indicated on **Figure 9**. A cap with an approximate 4 percent grade will be installed along the southern burial trench (500 by 250 ft) and remaining portion of the eastern burial trench (250 by 300 ft), to cover a total area of approximately 190,000 square feet (ft^2). Site preparation will include vegetation clearing, monitoring well abandonment, fence relocation, and the installation of erosion and sediment controls. Long-term O&M, including semiannual cap inspections, mowing, and maintenance, will be conducted for the life of the cap.

MNA will be conducted annually to evaluate the progress of natural attenuation of CVOCs over time. Natural degradation of CVOCs is expected to proceed, and favorable conditions exist at the location of the highest concentrations. NAIPs will be collected in support of MNA every 5 years. LTM of site-specific pesticides, PCBs, and metals and CA will be conducted to monitor concentrations over time and potential releases. CA will be monitored as an indicator of a release from the waste disposal area. If CA is detected, the remedy will need to be reevaluated.

LUCs were established for Site 69 in 2000 in accordance with the IROD. LUCs will be updated and maintained as part of the remedy to protect receptors from potential contact with buried waste and associated soil and groundwater, prevent unauthorized land use, and prevent aquifer use. LUCs including, but not limited to, land use restrictions in the Base Master Plan, filing a Notice of Contaminated Site with the Register of Deeds of Onslow County, and administrative procedures to prohibit unauthorized intrusive activities (e.g., excavation into the water table, drinking water well installation, or construction) will be implemented as part of the remedy to prevent exposure to the residual contamination on the site that exceeds the cleanup levels. Consideration of vapor intrusion is required prior to any new construction or changes to existing building use or structure within the LUC boundary. The LUCs will be maintained indefinitely as the buried waste will remain in place. The Navy and United States Marine Corps are responsible for implementing, maintaining, reporting on, and enforcing LUCs. Although the Navy and MCIEAST – MCB CAMLEJ may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Navy and MCIEAST – MCB CAMLEJ shall retain ultimate responsibility for the remedy integrity. The LUC performance objectives for Site 69 include the following:

- To prohibit unauthorized intrusive activities within the waste disposal area.
- To prohibit residential/recreational uses and development including, but not limited to, any form of housing, any kind of school, child-care facilities, playgrounds, and adult nursing facilities.
- To prohibit human consumption of or interaction with groundwater from the surficial and Castle Hayne aquifers underlying Site 69.
- To mitigate the potential for future vapor intrusion pathways.
- To inspect and maintain the integrity of any existing or future monitoring or remediation system at the site (including but not limited to the cap, groundwater monitoring wells, fences, and signs).

To achieve the LUC objectives, the Navy will implement the following LUCs for Site 69:

- **Access Control –** Fencing and signs around the perimeter of the site to protect Base personnel, recreational users, or trespassers from coming in contact with site hazards.
- **Intrusive Activities Control (Soil, Groundwater, and MEC) –** To restrict intrusive activities within the waste disposal area. This LUC boundary is defined by the perimeter fence at the site. Provide UXO support for any intrusive activities and/or munitions safety awareness training for anyone working in the area.

- **Aquifer Use Control –** To prohibit the withdrawal and use of groundwater, except for environmental monitoring, where groundwater contamination remains in place above concentrations that allow for unlimited use and unrestricted exposure. This LUC boundary, which encompasses the area within 1,000 ft of groundwater within the surficial and Castle Hayne aquifers with concentrations of COCs exceeding cleanup levels.
- **Industrial/Non-Industrial Use Control –** To evaluate future buildings and land use for potential vapor intrusion pathways, prior to construction, within the extent of groundwater contamination remaining in place above concentrations that allow for unlimited use and unrestricted exposure. Base personnel, through existing procedures, will perform the evaluation. This LUC boundary encompasses the waste disposal area and within 100 ft of surficial and Castle Hayne groundwater COCs exceeding cleanup levels.

The Navy will implement the following actions as part of the LUCs for Site 69:

- Incorporating land and groundwater use prohibitions into the MCIEAST–MCB CAMLEJ Base Master Plan, including consideration of vapor intrusion for new construction or modification to existing structures foundations within 100 ft of contaminated groundwater
- Recording a Notice of Contaminated Site filed in Onslow County real property records in accordance with North Carolina General Statutes (NCGSs) 143B-279.9 and 143B-279.10
- Maintaining the integrity of any current or future remedial or monitoring system, such as conducting site inspections to verify the integrity of the monitoring wells and to verify compliance with use restrictions

The estimated LUC boundaries are provided on **Figure 9** and the actual LUC boundaries will be finalized in the remedial design document. The LUC implementation actions, including monitoring and enforcement requirements, will be provided in a LUCIP that will be prepared as part of the Remedial Design document. The Navy will submit the LUCIP to USEPA and NCDENR for review and approval pursuant to the primary document review procedures stipulated in the FFA within 90 days of the ROD signature. The Navy will maintain, monitor (including conducting periodic inspections), and enforce the LUCs according to the requirements contained in the LUCIP and the ROD.

2.10.3 Expected Outcomes of the Selected Remedy

Current land uses are expected to continue at Site 69 and there are no other planned land uses in the foreseeable future, or plans for development of the site. **Table 17** summarizes the unacceptable risk, the RAOs identified to address the risk, the remedy component intended to achieve the RAO, the metric that measures the remedial action progress, and the expected outcome that the remedy will have.

TABLE 17
Expected Outcomes of the Selected Remedy

Risk	Remedial Action Objective	Remedy Component	Metric	Expected Outcome
Human and ecological exposure to buried wastes and associated soil	Prevent exposure to the waste disposal area and associated soil and groundwater until concentrations meet levels that allow for unlimited use and unrestricted exposure Minimize exposure to potential CA and chemical waste to the maximum extent practicable	Capping	Maintain cap for 30 years to provide barrier for receptors and evaluate effectiveness annually by comparison of current COC concentrations in downgradient monitoring wells to preconstruction concentrations and the cleanup levels	Current restricted land use
		LUCs	LUCs to prevent intrusive activities and industrial or residential use, and fencing and signs indefinitely as buried waste remains in place	
Future industrial worker and residential exposure to COCs in groundwater and indoor air	Restore groundwater quality at Site 69 to meet NCDENR and federal primary drinking water standards, based on the classification of the aquifer as a potential source of drinking water (Class GA or Class GSA) under 15A NCAC 02L.0201	MNA/LTM	Implement MNA/LTM until each groundwater COC is at or below its respective cleanup level for 4 consecutive monitoring events CA will be monitored as an indicator of a release from the waste disposal area and if CA is detected, the remedy will need to be reevaluated	Current restricted groundwater use
		LUCs	Maintain LUCs to prevent intrusive activities, industrial or residential use, and aquifer use indefinitely as buried waste (source material) remains in-place	
Discharge of COCs into groundwater and surface water	Reduce infiltration and leaching of contaminants from waste into groundwater to the maximum extent practicable Minimize potential degradation of the New River by COC-affected groundwater	Capping	Maintain cap for 30 years to provide barrier for infiltration and reduce mobility of COCs in groundwater to prevent discharging into the New River Evaluate effectiveness annually by comparison of current COC concentrations in downgradient monitoring wells to preconstruction concentrations and the cleanup levels	Current restricted groundwater use
		MNA/LTM	Implement MNA/LTM until each groundwater COC is at or below its respective cleanup level for 4 consecutive monitoring events	

2.10.4 Statutory Determinations

Remedial actions undertaken at NPL sites must meet the statutory requirements of Section 121 of CERCLA and thereby achieve adequate protection of human health and the environment, comply with ARARs of both federal and state laws and regulations, be cost effective, and use, to the maximum extent practicable, permanent solutions and alternative treatment or resource recovery technologies. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, and/or mobility of hazardous waste as the principal element. The following discussion summarizes the statutory requirements that are met by the Selected Remedy.

Protection of Human Health and the Environment – Buried waste, contaminated soil, and groundwater present an unacceptable risk to human health and the environment; however, LUCs currently prevent any current or future exposure to this area and will be updated and maintained. The Selected Remedy includes a cap to prevent potential exposure to buried wastes (some of which are considered PTWs) and associated soil and provide a barrier for potential receptors and infiltration, MNA to evaluate the progress of natural attenuation of VOCs over time, and LTM of site-specific metals, PCBs, and pesticides and CA to monitor concentrations over time, migration, and potential releases. LUCs will be updated and maintained to protect receptors from potential contact with buried waste and associated soil and groundwater, prevent unauthorized land use, and prevent aquifer use. As the waste disposal area remains intact, implementation of the cap may pose short-term risks to workers through the use of heavy equipment and soil disturbance. These risks will be minimized through the use of engineering and safety controls, appropriate PPE, and air monitoring.

Compliance with ARARs and To-Be-Considered (TBC) Criteria – Section 121(d) of CERCLA, as amended, specifies, in part, that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more-stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs) to the hazardous substances or particular circumstances at a site or obtain a waiver. See also 40 CFR 300.430(f)(1)(ii)(B). ARARs include only federal and state environmental or facility citing laws/ regulations and do not include occupational safety or worker protection requirements. Compliance with Occupational Safety and Health Administration (OSHA) standards is required by 40 CFR 300.150 and therefore the CERCLA requirement for compliance with or wavier of ARARs does not apply to OSHA standards. In addition to ARARs, the lead and support agencies may, as appropriate, identify other advisories, criteria, or guidance to be considered for a particular release. The TBC category consists of advisories, criteria, or guidance developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies. See 40 CFR 300.400(g)(3). In accordance with 40 CFR 300.400(g), Navy, USEPA, and NCDENR have identified the ARARs and TBCs for the selected remedy. **Appendix A** lists respectively the Chemical-, Location- and Action-Specific ARARs/TBCs for the Selected Remedy. The Selected Remedy will meet all identified ARARs.

Cost-Effectiveness – The Selected Remedy is cost effective and represents a reasonable value for the money to be spent. The following definition was used to determine cost effectiveness, "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness NCP §300.430(f)(1)(ii)(D)." This analysis was accomplished by evaluating the overall effectiveness of those alternatives satisfying the threshold criteria. The costs are proportional to overall effectiveness by achieving long-term effectiveness and permanence within a reasonable timeframe.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable – The Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at Site 69, considering the presence of CA and demonstrated limited effectiveness of certain in-situ groundwater treatment technologies. Since long-term effectiveness and permanence, along with reduced mobility, are achieved in the shortest timeframe with the Selected Remedy, the Navy, MCIEAST-MCB CAMLEJ, USEPA, and NCDENR determined that the Selected Remedy provides the best balance of tradeoffs in terms of balancing the criteria, while also considering the statutory preference for treatment as a principal element and considering State and community acceptance.

The Selected Remedy addresses the source material in the waste disposal area and is the presumptive remedy approach for military landfills addressed under CERCLA, except that when PTWs are present, USEPA expects treatment or removal of such source materials to the maximum extent possible. The Selected Remedy satisfies long-term effectiveness by containing waste and contaminants and by providing a barrier for potential receptors and infiltration, achieving reduction of mobility of COCs in groundwater. LUCs and MNA and LTM will prevent exposure to COCs and monitor effectiveness of treatment and natural degradation in groundwater.

Preference for Treatment as a Principal Element – While the remedy does not satisfy the statutory preference for treatment as a principal element, it does provide a cover which minimizes infiltration and resulting contaminant leaching to groundwater to reduce further migration of the principal threat waste, which the FFA parties determined through the FS was an acceptable alternative to reduce the mobility of the PTWs. The high risk

associated with removal and transportation of CA and the limited acceptable disposal facilities for CA waste make the USEPA preference for removal of the principal threat waste an impractical alternative at this time. Trends over time indicate that MNA will be effective and degrade VOCs in groundwater in a reasonable timeframe. The groundwater is not used for drinking water and LUCs will prevent exposure to waste and groundwater.

Five-Year Review Requirements – Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment in accordance with CERCLA Section 121(c) and the NCP at 40 *Code of Federal Regulations* (CFR) 300.430 (f)(4)(ii). If the FFA parties determine during the Five-Year Review that the remedy is not functioning properly and is not protective of human health and the environment, the parties will determine whether the Navy must revise the remedy to take additional remedial actions. Also, if investigation or treatment technologies are discovered that promote feasibility of further investigation and remediation of CA, a more conclusive search for potential CA will be considered in the Five-Year Review.

2.11 Community Participation

The Navy, MCIEAST-MCB CAMLEJ, USEPA, and NCDENR provide information regarding the cleanup of MCIEAST-MCB CAMLEJ to the public through the community involvement program, which includes a Restoration Advisory Board (RAB), public meetings, the Administrative Record file for the site, and announcements published in local newspapers. RAB meetings continue to be held to provide an information exchange among community members, the Navy, MCIEAST-MCB CAMLEJ, USEPA, and NCDENR. These meetings are open to the public and are held quarterly.

A public meeting to present the PRAP for Site 69 was held on August 16, 2012, at the Coastal Carolina Community College. The PRAP identified the Preferred Alternative as capping with LUCs for the waste disposal area and associated soil and MNA and LTM with LUCs for groundwater. In accordance with Sections 113 and 117 of CERCLA, the Navy provided a public comment period from August 16, 2012, through September 16, 2012. Public notice of the meeting and availability of documents was placed in *The Jacksonville Daily News* on August 10, *The Globe on* August 9, and the *RotoVu* on August 15.

The Administrative Record, Community Involvement Plan, and final technical reports concerning Site 69 can be obtained from the IRP Web site: http://go.usa.gov/jZi. Internet access is available to the public at the following location:

Onslow County Public Library
58 Doris Avenue East
Jacksonville, North Carolina 28540
(910) 455-7350

2.12 Documentation of Significant Changes

The PRAP for Site 69 was released for public comment on August 16, 2012. No comments were submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the PRAP, were necessary or appropriate.

3 Responsiveness Summary

The participants in the Public Meeting held on August 16, 2012, included representatives of the Navy, MCIEAST-MCB CAMLEJ, USEPA, and NCDENR. RAB and community members attended the meeting. Questions received during the public meeting were general inquiries and are described in the public meeting minutes in the Administrative Record file. There were no comments received at the public meeting requiring amendment to the PRAP and no additional written comments, concerns, or questions were received from community members during the public comment period.

Appendix A
ARARs and TBC

TABLE A-1
Chemical-Specific ARARs
Record of Decision
Operable Unit No. 14 (Site 69)
MCIEAST-MCB CAMLEJ, North Carolina

Media	Requirement	Prerequisite	Citation
Federal and North Carolina Chemical-Specific ARARs			
Classification of contaminated groundwater	Groundwaters in the state naturally containing 250 milligrams per liter (mg/L) or less of chloride are *classified as GA (existing or potential source of drinking water supply for humans)* under 15A North Carolina Administrative Code (NCAC) 02L .0201(1).	Groundwaters located within the boundaries or under the extraterritorial jurisdiction of the State of North Carolina – **Applicable**	15A NCAC 02L .0302(1)
	Groundwaters in the state naturally containing greater than 250 mg/L of chloride are *classified as GSA* under 15A NCAC 02L .0201(2).		15A NCAC 02L .0302(2)
Restoration of contaminated groundwater	Shall not exceed the groundwater quality standards (1) for contaminants specified in Paragraphs (g) or (h) for the site related contaminants of concern.	Class GA or GSA groundwaters with contaminant(s) concentrations exceeding standards listed in 15A NCAC 02L .0202 – **Relevant and Appropriate**	15A NCAC 02L .0202(a), (b), and (g)
	Chromium (10 micrograms per liter [µg/L]), thallium (2 µg/L), alpha-BHC (0.02 µg/L), aroclor-1260 (0.5 µg/L), dieldrin (0.002 µg/L), heptachlor epoxide (0.004 µg/L), 1,1,2,2-PCA (0.2 µg/L), 1,1,2-TCA (5 µg/L), 1,2-DCA (0.4 µg/L), cis-1,2-DCE (70 µg/L), TCE (3 µg/L), trans-1,2-DCE (100 µg/L), VC (0.03 µg/L).		
	Shall not exceed the Safe Drinking Water Act National Revised Primary Drinking Water Regulations: maximum contaminant levels (MCLs) for organic contaminants specified in 40 *Code of Federal Regulations* (CFR) 141.61(a).	Groundwaters classified as GA or GSA, which are an existing or potential source of drinking water – Relevant and Appropriate	40 CFR 141.61(a) 15A NCAC 18C .1518
Protection of adjacent surface water body	Toxic substances shall not exceed the numerical quality standards (maximum permissible levels) to protect human health from carcinogens through consumption of fish (and shellfish).	Tidal Salt Waters classified as Class SC (under 15A NCAC 02B .0220) with chemical concentrations exceeding 15A NCAC 02B Standards - **Relevant and Appropriate**	15A NCAC 02B .0208(a)(2)(B)
	Chromium (20 µg/L), thallium (0.47 µg/L), alpha-BHC (0.0049 µg/L), aroclor-1260 (0.000064 µg/L), dieldrin (0.00005 µg/L), heptachlor epoxide (0.000039 µg/L), 1,1,2,2-PCA (4 µg/L), 1,1,2-TCA (16 µg/L), 1,2-DCA (37 µg/L), cis-1,2-DCE (720 µg/L), TCE (30 µg/L), trans-1,2-DCE (10,000 µg/L), VC (2.4 µg/L).		
	If the groundwater plume is expected to intercept surface waters, the groundwater discharge will not possess contaminant concentrations that would result in violations of standards for surface waters.	Contaminant concentrations in groundwater present at concentrations that cause a violation of the surface water standards at a surface water body – **Relevant and Appropriate**	15A NCAC 2L. 0106(k)(5)
	Monitor and undertake management practices for sources of pollution such that water quality standards and best usage of receiving waters and all downstream waters will not be impaired.	Indirect discharges of waste or other source of water pollution into Tidal Salt Waters classified as SC – **Relevant and Appropriate**	15A NCAC 02B .0203

Notes:
[1] Groundwater quality standards established on the basis of a national secondary drinking water standards are not used as remediation goals since these are based on taste, odor and other considerations unrelated to human health.

TABLE A-2
Action-Specific ARARs
Record of Decision
Operable Unit No. 14 (Site 69)
MCIEAST-MCB CAMLEJ, North Carolina

Action	Requirement	Prerequisite	Citation
Federal and North Carolina Action-Specific ARARs			
General Construction Standards — All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.)			
Managing stormwater runoff from land-disturbing activities	Shall take all reasonable measures to protect all public and private property from damage caused by such activities.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-53) of more than 1 acre of land – **Applicable**	15A NCAC 4B.0105
	Erosion and sedimentation control plan must address the following basic control objectives:		15A NCAC 4B.0106
	(1) Identify areas subject to severe erosion and offsite areas especially vulnerable to damage from erosion and sedimentation		
	(2) Limit the size of the area exposed at any one time		
	(3) Limit exposure to the shortest feasible time		
	(4) Control surface water run-off originating upgrade of exposed areas		
	(5) Plan and conduct land-disturbing activity so as to prevent offsite sedimentation damage		
	(6) Include measures to control velocity of stormwater runoff to the point of discharge		
	Erosion and sedimentation control measures, structures, and devices shall be planned, designed, and constructed to provide protection from the runoff of 10-year storm.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-53) of more than 1 acre of land – **Applicable**	15A NCAC 4B.0108
	Shall conduct activity so that the post-construction velocity of the 10-year storm runoff in the receiving watercourse to the discharge point does not exceed the parameters provided in this Rule.		15A NCAC 4B.0109
	Shall install and maintain all temporary and permanent erosion and sedimentation control measures.		15A NCAC 4B.0113
	Erosion and sedimentation control measures, structures, and devices with High Quality Water (HQW) zones shall be planned, designed, and constructed to provide protection from the runoff of the 25-year storm.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-52) of more than 1 acre of land in HQW zones – **Applicable**	15A NCAC 4B.0124(b)
	Provisions for ground cover sufficient to restrain erosion must be provided for any portion of the land-disturbing activity with 15 working days or 60 calendar days following completion of the construction or development, whichever period is shorter.		15A NCAC 4B.0124(e)
	Implement good construction management techniques, best management practices for sediment and erosion controls, and stormwater management measures in accordance with 15A NCAC 02H .1008 to ensure that storm water discharges are in compliance.	Development activity (otherwise requiring a stormwater permit) within 1 mile of and draining to waters classified as HQW – **Relevant and Appropriate**	15A NCAC 02H .1006, NC General Permit CNCG 0100000

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Action	Requirement	Prerequisite	Citation
Monitoring Well Installation, Operation, and Abandonment			
Construction of groundwater monitoring well(s)	No well shall be located, constructed, operated, or repaired in any manner that may adversely impact the quality of groundwater.	Installation of wells (including temporary wells, monitoring wells) other than for water supply – **Applicable**	15A NCAC 02C .0108(a)
	Shall be located, designed, constructed, operated, and abandoned with materials and by methods that are compatible with the chemical and physical properties of the contaminants involved, specific site conditions, and specific subsurface conditions.		15A NCAC 02C .0108(c)
	Monitoring and recovery well boreholes shall not penetrate to a depth greater than the depth to be monitored or the depth from which contaminants are to be recovered. Any portion of the borehole that extends to a depth greater than the depth to be monitored or the depth from which contaminants are to be recovered shall be groundwater completely to prevent vertical migration of contaminants.		15A NCAC 02C .0108 (d)
	Shall be constructed in such a manner as to preclude the vertical migration of contaminants with and along borehole channel.	Installation of wells (including temporary wells, monitoring wells) other than for water supply – **Applicable**	15A NCAC 02C .0108(f)
	The well shall be constructed in such a manner that water or contaminants from the land surface cannot migrate along the borehole annulus into any packing material or well screen area.		15A NCAC 02C .0108(g)
	Packing material placed around the screen shall extend at least 1 foot above the top of the screen. Unless the depth of the screen necessitates a thinner seal, a 1-foot-thick seal, comprised of chip or pellet bentonite or other material approved by the Department as equivalent, shall be emplaced directly above and in contact with the packing material.		15A NCAC 02C .0108(h)
	Grout shall be placed in the annular space between the outermost casing and the borehole wall from the land surface to the top of the bentonite seal above any well screen or to the bottom of the casing for open end wells. The grout shall comply with Paragraph (e) of Rule .0107 of this Section except that the upper 3 feet of grout shall be concrete or cement grout.		15A NCAC 02C .0108(i)
	All wells shall be grouted within 7 days after the casing is set. If the well penetrates any water-bearing zone that contains contaminated or saline water, the well shall be grouted within one day after the casing is set.		15A NCAC 02C .0108(j)

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Action	Requirement	Prerequisite	Citation
Construction of groundwater monitoring well(s) (cont.)	Shall be secured with a locking well cap to ensure against unauthorized access and use. Shall be equipped with a steel outer well casing or flush-mount cover, set in concrete, and other measures sufficient to protect the well from damage by normal site activities.		15A NCAC 02C .0108(k) and (l)
	The well casing shall be terminated no less than 12 inches above land surface unless all of the following conditions are met: (1) site-specific conditions directly related to business activities, such as vehicle traffic, would endanger the physical integrity of the well and (2) the well head is completed in such a manner so as to preclude surficial contaminants from entering the well.		15A NCAC 02C .0108(n)
	Shall have permanently affixed an identification plate. The identification plate shall be constructed of a durable, waterproof, rustproof metal, or other material approved by the Department as equivalent and shall contain the following information: (1) Well contractor name and certification number (2) Date well completed (3) Total depth of well (4) A warning that the well is not for water supply and that the groundwater may contain hazardous materials (5) Depth(s) to the top(s) and bottom(s) of the screen(s) (6) The well identification number or name assigned by the well owner		15A NCAC 02C .0108(o)
	Shall be developed such that the level of turbidity or settleable solids does not preclude accurate chemical analyses of any fluid samples collected or adversely affect the operation of any pumps or pumping equipment.		15A NCAC 02C .0108(p)
	Shall be constructed in such a manner as to preclude the vertical migration of contaminants within and along the borehole channel.	Installation of temporary wells and all other non-water supply wells – **Applicable**	15A NCAC 02C .0108(s)
Implementation of groundwater monitoring system	Shall be constructed in a manner that will not result in contamination of adjacent groundwaters of a higher quality.	Installation of monitoring system to evaluate effects of any actions taken to restore groundwater quality, as well as the efficacy of treatment – **Applicable**	15A NCAC 02L .0110 (b)

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Action	Requirement	Prerequisite	Citation
Maintenance of groundwater monitoring well(s)	Every well shall be maintained by the owner in a condition whereby it will conserve and protect groundwater resources, and whereby it will not be a source or channel of contamination or pollution to the water supply or any aquifer.	Installation of wells (including temporary and monitoring wells) other than for water supply – **Applicable**	15A NCAC 02C .0112(a)
	Broken, punctured, or otherwise defective or unserviceable casing, screens, fixtures, seals, or any part of the well head shall be repaired or replaced, or the well shall be abandoned pursuant to 15A NCAC 02C .0113.		15A NCAC 02C .0112(d)
	All materials used in the maintenance, replacement, or repair of any well shall meet the requirements for new installation.		15A NCAC 02C .0112(c)
	No well shall be repaired or altered such that the outer casing is completed less than 12 inches above land surface. Any grout excavated or removed as a result of the well repair shall be replaced in accordance with Rule .0107(f) of this Section.		15A NCAC 02C .0112(f)
Abandonment of groundwater monitoring well(s)	Shall be abandoned by filling the entire well up to land surface with grout, dry clay, or material excavated during drilling of the well and then compacted in place.	Permanent abandonment of wells (including temporary wells, monitoring wells, and test borings) other than for water supply *less than 20 feet in depth* and which do not penetrate the water table – **Applicable**	15A NCAC 02C .0113(d)(1)
	Shall be abandoned by completely filling with a bentonite or cement-type grout.	Permanent abandonment of wells (including temporary wells, monitoring wells, and test borings) other than for water supply *greater than 20 feet in depth* and which do not penetrate the water table – **Applicable**	15A NCAC 02C .0113(d)(2)
	All wells shall be permanently abandoned in which the casing has not been installed or from which the casing has been removed, prior to removing drilling equipment from the site.	Permanent abandonment of wells (including temporary wells) other than for water supply – **Applicable**	15A NCAC 02C .0113(f)
Waste Characterization and Storage — Primary Wastes (i.e., excavated contaminated soils and purge water) and Secondary Wastes (e.g., PPE and used equipment)			
Characterization of solid waste (e.g., well soil cuttings)	Must determine if solid waste is hazardous waste or if waste is excluded under 40 CFR 261.4(b).	Generation of solid waste as defined in 40 CFR 261.2 and that is not excluded under 40 CFR 261.4(a) – **Applicable**	40 CFR 262.11(a) and (b)
	Must determine if waste is listed under 40 CFR Part 261.		40 CFR 262.11(b) 15A NCAC 13A .0107
	Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used.		40 CFR 262.11(c) 15A NCAC 13A .0107
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be hazardous – **Applicable**	40 CFR 262.11(d) 15A NCAC 13A .0107

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Action	Requirement	Prerequisite	Citation
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 CFR 264 and 268.	Generation of Resource Conservation and Recovery Act (RCRA) hazardous waste for storage, treatment or disposal – **Applicable**	40 CFR 264.13(a)(1) 15A NCAC 13A .0109
Determinations for management of hazardous waste	Must determine the underlying hazardous constituents (as defined in 40 CFR 268.2[i]) in the waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal – **Applicable**	40 CFR 268.9(a) 15A NCAC 13A .0112
	Must determine if the waste is restricted from land disposal under 40 CFR 268 *et seq.* by testing in accordance with prescribed methods or use of generator knowledge of waste.	Generation of hazardous waste for storage, treatment or disposal – **Applicable**	40 CFR 268.7(a)(1) 15A NCAC 13A .0112
	Must determine each United States Environmental Protection Agency (USEPA) Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 CFR 268.40 et. seq.		40 CFR 268.9(a) 15A NCAC 13A .0112
Storage of solid waste	All solid waste shall be stored in such a manner as to prevent the creation of a nuisance, insanitary conditions, or a potential public health hazard.	Generation of solid waste which is determined *not* to be hazardous – **Relevant and Appropriate**	15A NCAC 13B .0104(f)
	Containers for the storage of solid waste shall be maintained in such a manner as to prevent the creation of a nuisance or insanitary conditions. Containers that are broken or that otherwise fail to meet this Rule shall be replaced with acceptable containers.		15A NCAC 13B .0104(e)
Temporary storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that or all of the following occur:	Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 – **Applicable**	40 CFR 262.34(a) 15A NCAC 13A .0107
	• Waste is placed in containers that comply with 40 CFR 265.171-173		40 CFR 262.34(a)(1)(i)
	• The date upon which accumulation begins is clearly marked and visible for inspection on each container		40 CFR 262.34(a)(2) 15A NCAC 13A .0107
	• Container is marked with the words “hazardous waste”		40 CFR 264.34(a)(3) 15A NCAC 13A .0107
	• Container may be marked with other words that identify the contents.	Accumulation of 55 gallons or less of RCRA hazardous waste at or near any point of generation – **Applicable**	40 CFR 262.34(c)(1) 15A NCAC 13A .0107
	Area must have a containment system designed and operated in accordance with 40 CFR 264.175(b).	Storage of RCRA hazardous waste in containers with *free liquids* – **Applicable**	40 CFR 264.175(a) 15A NCAC 13A .0109
	Area must be sloped or otherwise designed and operated to drain liquid resulting from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage of RCRA hazardous waste in containers that do not contain free liquids (other than F020, F021, F022, F023,F026 and F027) – **Applicable**	40 CFR 264.175(c)(1) and (2) 15A NCAC 13A .0109

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Action	Requirement	Prerequisite	Citation
Closure of RCRA container storage unit	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with 40 CFR 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of Parts 262 through 266 of this chapter.]	Storage of RCRA hazardous waste in containers in a unit with a containment system – **Applicable**	40 CFR 264.178 15A NCAC 13A .0109
Disposal of solid waste (e.g., contaminated soil)	Shall ensure that waste is disposed of at a site or facility that is permitted to receive the waste.	Generation of solid waste intended for offsite disposal – **Relevant and Appropriate**	15A NCAC 13B .0106(b)
Disposal of RCRA hazardous waste in a land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste – **Applicable**	40 CFR 268.40(a) 15A NCAC 13A .0112
	All underlying hazardous constituents (as defined in 40 CFR 268.2[i]) must meet the Universal Treatment Standards (UTS), found in 40 CFR 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the Clean Water Act, that is Clean Water Act equivalent, or that is injected into a Class I nonhazardous injection well – **Applicable**	40 CFR 268.40(e) 15A NCAC 13A .0112
	To determine whether a hazardous waste indentified in this section exceeds the applicable treatment standards of 40 CFR 268.40, the initial generator must test a sample of the waste extract or the entire waste, depending on whether the treatment standards are expressed as concentration in the waste extract or waste, or the generator may use knowledge of the waste. If the waste contains constituents (including UHCs in the characteristic wastes) in excess of the applicable UTS levels in 40 CFR 268.48, the waste is prohibited from land disposal, and all requirements of Part 268 are applicable, except as otherwise specified.	Land disposal of RCRA toxicity characteristic wastes (D004-D011) that are newly identified (i.e., wastes, soil, or debris identified by the TCLP but not the Extraction Procedure) – **Applicable**	40 CFR 268.34(f)15A NCAC 13A .0112
Disposal of RCRA hazardous waste in a land-based unit	Must be treated according to the alternative treatment standards of 40 CFR 268.49(c) or according to the UTSs specified in 40 CFR 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal	Land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils – **Applicable**	40 CFR 268.49(b) 15A NCAC 13A .0112

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Action	Requirement	Prerequisite	Citation
Institutional Controls for Contamination Left in Place			
Notice of Contaminated Site	Prepare and certify by professional land surveyor a survey plat which identifies contaminated areas which shall be entitled "NOTICE OF CONTAMINATED SITE."	Contaminated site subject to current or future use restrictions included in a remedial action plan as provided in G.S. 143B-279.9(a) – **To-Be-Considered**	NCGS 143B-279.10(a)
	Notice shall include a legal description of the site that would be sufficient as a description in an instrument of conveyance and meet the requirements of NCGS 47-30 for maps and plans.		
	The Survey plat shall identify the following: • The location and dimensions of any disposal areas and areas of potential environmental concern with respect to permanently surveyed benchmarks • The type location, and quantity of contamination known to exist on the site • Any use restriction on the current or future use of the site		NCGS 143B-279.10(a)(1)-(3)
	The deed or other instrument of transfer shall contain in the description section, in no smaller type than used in the body of the deed or instrument, a statement that the property is a contaminated site and reference by book and page to the recordation of the Notice.	Contaminated site subject to current or future use restrictions as provided in G.S. 143B-279.9(a) that is to sold, leased, conveyed or transferred – **To-Be-Considered**	NCGS 143B-279.10(e)
Discharge of dredge-and-fill			
Discharge of dredge-and-fill	No discharge of dredged or fill material will be allowed unless appropriate and practicable steps are taken that minimize potential adverse impacts of the discharge on the aquatic ecosystem.	Discharges of dredged or fill material to surface waters, including wetlands – **Applicable**	40 CFR 230.10(d); 33 CFR 320.4(a), (b), (d), (p), (r)
Capping Waste in Place - Landfill Closure and Post-Closure			
Landfill closure performance standard	Must close the unit in a manner that achieves the following: • Minimizes the need for further maintenance • Controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to ground or surface waters or to the atmosphere • Complies with the relevant closure and post-closure requirements of 40 CFR 264.310	Closure of a RCRA hazardous waste management unit – **Relevant and Appropriate**	40 CFR 264.111(a)-(c)
Landfill cover design and construction	Must cover the landfill or cell with a final cover designed and constructed to achieve the following: • Provide long-term minimization of migration of liquids through the closed landfill	Closure of a RCRA hazardous waste management unit – **Relevant and Appropriate**	40 CFR 264.310(a)(1)–(5)

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Action	Requirement	Prerequisite	Citation
	• Function with minimum maintenance • Promote drainage and minimize erosion or abrasion of the cover • Accommodate settling and subsidence so that the cover's integrity is maintained • Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present		
	This document recommends and describes a design for landfill covers that will meet the requirements of RCRA regulations. It is a multilayered system consisting, from the top down, of the following: • A top layer of at least 60 centimeters (cm) of soil, either vegetated or armored at the surface • A granular or geosynthetic drainage layer with a hydraulic transmissivity no less than 3 x 10^{-5} cm^2/second • A two-component low permeability layer comprised of (1) a flexible membrane liner installed directly on (2) a compacted soil component with a hydraulic conductivity no greater than 1 x 10^{-7} cm/second. • Optional layers may be added (e.g., a biotic barrier layer or a gas vent layer, depending on the need).	Construction of a RCRA hazardous waste landfill final cover – **To-Be-Considered**	*USEPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments,* USEPA OSWER 530 – SW – 89 – 047, (July 1989)
Run–on/run–off control systems for landfill cover	Run-on control system must be capable of preventing flow onto the active portion of the landfill during peak discharge from a 25-year storm event.	Construction of a RCRA hazardous waste landfill cover – **Relevant and Appropriate**	40 CFR 264.301(g)
	Runoff management system must be able to collect and control the water volume from a runoff resulting from a 24-hour, 25-year storm event.		40 CFR 264.301(h)
Protection of closed landfill	Post-closure use of property must never be allowed to disturb the integrity of the final cover, liners, or any other components of the containment system or the facility's monitoring system unless necessary to reduce a threat to human health or the environment.	Closure of a RCRA hazardous waste landfill – **Relevant and Appropriate**	40 CFR 264.117 (c)
General post-closure care for closed landfill	Owner or operator must do the following: • Maintain the effectiveness and integrity of the final cover including making repairs to the cap as necessary to correct effects of settling, erosion, etc.; • Prevent run-on and runoff from eroding or otherwise damaging final cover • Protect and maintain surveyed benchmarks used to locate waste cells	Closure of a RCRA hazardous waste landfill – **Relevant and Appropriate**	40 CFR 264.310(b)(1), (5) and (6)

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Action	Requirement	Prerequisite	Citation
Post-closure notices for closed landfill	Must submit to the local zoning authority a record of the type, location, and quantity of hazardous wastes disposed of within each cell of the unit.	Closure of a RCRA hazardous waste landfill – **Relevant and Appropriate**	40 CFR 264.119(a)
	Must record, in accordance with state law, a notation on the deed to the facility property—or on some other instrument that is normally examined during a title search—that will in perpetuity notify any potential purchaser of the property that the following: • Land has been used to manage hazardous wastes • Its use is restricted under 40 CFR Part 264 Subpart G regulations • The survey plat and record of the type, location, and quantity of hazardous wastes disposed within each cell or other hazardous waste disposal unit of the facility required by Sections 264.116 and 264.119(a) have been filed with the local zoning authority and with the USEPA Regional Administrator	Closure of a RCRA hazardous waste landfill – **Relevant and Appropriate**	40 CFR 264.119(b)(1)(i)-(iii)
Transportation of Wastes			
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the Hazardous Material Transfer Act and Department of Transportation Hazardous Materials Regulations at 49 CFR 171-180.	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material – **Applicable**	49 CFR 171.1(c)
Transportation of hazardous waste onsite	The generator manifesting requirements of 40 CFR 262.20-262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way – **Applicable**	40 CFR 262.20(f)
Transportation of hazardous waste offsite	Must comply with the generator requirements of 40 CFR 262.20-23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain USEPA identification number.	Preparation and initiation of shipment of RCRA-hazardous waste offsite – **Applicable**	40 CFR 262.10(h); 15A NCAC 13A .0107
	Are not subject to any requirements of 40 CFR Parts 261 through 268 or 270 when the following occur: • The sample is being transported to a laboratory for the purpose of testing • The sample is being transported back to the sample collector after testing • The sample is being stored by sample collector before transport to a lab for testing	Samples of solid waste or a sample of water, soil for purpose of conducting testing to determine its characteristics or composition – **Applicable**	40 CFR 261.4(d)(1)(i)-(iii) 15A NCAC 13A .0106

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Action	Requirement	Prerequisite	Citation
	To qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements • Ensure that the information provided in (1) thru (5) of this section accompanies the sample • Package the sample so that it does not leak, spill, or vaporize from its packaging		40 CFR 261.4(d)(2)(i)(A) and (B) 15A NCAC 13A .0106

TABLE A-3
Location-Specific ARARs
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Location	Requirement	Prerequisite	Citation
Federal and North Carolina Location-Specific ARARs			
Presence of wetlands	Concentrations or combination of substances, which are toxic or harmful to human, animal, or plant life may not be present in amounts, which individually or cumulatively, can cause adverse impacts on existing wetland uses.	Activities within, wetlands as defined by G.S. 143-212(6) – **Applicable**	15A NCAC 02B.0231(b)(4)
	Standards provided in 15A NCAC 02B.0231(b)(1), (2), (3), (5), and (6) shall be used to ensure the maintenance or enhancement of the existing uses of wetlands identified in 15A NCAC 02B.0231(a).		
	Requires federal agencies to evaluate action to minimize the destruction, loss or degradation of wetlands and to preserve and enhance beneficial values of wetlands.	Actions that involve potential impacts to or take place within wetlands – **To-Be-Considered**	Executive Order 11990 – *Protection of Wetlands* Section 1.(a)
Location encompassing aquatic ecosystem as defined in 40 CFR 230.3(c)	No discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem or if it will cause or contribute significant degradation of the waters of the US.	Action that involves the discharge of dredged or fill material into waters of the United States including jurisdictional wetlands – **Relevant and Appropriate**	40 CFR 230.10(a) and (c)
	Except as provided in § 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps in accordance with Subpart H at 40 CFR 230.70 *et seq*. have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem.		40 CFR 30.10(d) Clean Water Act Regulations - Section 404(b) Guidelines
	Must comply with the substantive requirements of the Nationwide Permit 38 General Conditions, as appropriate, any regional or case-specific conditions recommended by the U.S. Corps District Engineer, after consultation.	Onsite Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) action conducted by federal agency that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **Relevant and Appropriate**	Nation Wide Permit (38) Cleanup of Hazardous and Toxic Waste 33 CFR 323.3(b)
Presence of floodplain designated as such on a map	Shall consider alternatives to avoid, to the extent possible, adverse effects on and incompatible development in the floodplain.	Federal actions that involve potential impacts on, or take place within, floodplains – **To-Be-Considered**	33 CFR 323.3(b)

TABLE A-3
Location-Specific ARARs
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Location	Requirement	Prerequisite	Citation
Presence of federally endangered or threatened species, as designated in 50 CFR 17.11 and 17.12 *or* critical habitat of such species listed in 50 CFR 17.95	Actions that jeopardize the existence of a listed species or results in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken.	Action that is likely to jeopardize fish, wildlife, or plant species or destroy or adversely modify critical habitat – **Applicable**	16 United States Code (U.S.C.) 1531 *et seq*., Sect. 7(a)(2)
	Except as provided in the rule, no person may take the specified reptiles.	Action that is likely to jeopardize or adversely modify critical habitat for American alligator, green turtle, and/or loggerhead turtle – **Applicable**	50 CFR 17.42(a) and (b)
Presence of Migratory Birds listed in 50 CFR 10.13	No person may take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such bird except as may be permitted under the terms of a valid permit issued pursuant to the provisions of this part and Part 13 of this chapter, or as permitted by regulations in this part, or Part 20 of this subchapter (the hunting regulations).	Actions that have potential impacts on, or is likely to result in a 'take' (as defined in 50 CFR 10.12) of migratory birds – **Applicable**	*Migratory Bird Treaty Act*, 16 U.S.C 703 (a) 50 CFR 21.11
Coastal zone as defined in 16 U.S.C.§1453	Federal agency shall determine which of their activities affect any coastal use or resource of States with approved management programs. If agency determines activity has no effects on coastal use or resource, and a negative determination under § 930.35 is not required, then coordination with state agencies under Section 307 of the Act is not required. Activities must be consistent with, to the area that will affect maximum extent practicable, State coastal zone management programs. The state agency and federal agencies may agree to exclude environmentally beneficial agency activities (either on a case-by-case basis or for a category of activities) from further state agency consistency review. NOTE: Consultation is generally considered an 'administrative' requirement and therefore under CERCLA 121(e)(1) a federal agency is not required to perform. However, such consultation is strongly recommended considering under 50 CFR 930.34. Federal agencies shall provide state(s) with a consistency determination.	Federal agency activity that may have effect on any coastal use or resource as defined in 15 CFR 930.11 – **Applicable**	15 CFR 930.33(a)(1), (a)(2), (a)(4); (b); .35(a), (b); .36(a) Coastal Zone Management Act of 1972, 16 U.S.C.§1451 et. seq.

Appendix B
Acronyms and Abbreviations

Acronyms and Abbreviations

°C	degree(s) Celsius
cm	centimeter(s)
ARAR	applicable or relevant and appropriate requirement
ASR	Archive Search Report
bgs	below ground surface
CA	chemical agent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	constituent of concern
CSF	cancer toxicity factor
CSM	conceptual site model
CTE	Central Tendency Exposure
CVOC	chlorinated volatile organic compound
DCA	dichloroethane
DCE	dichloroethene
DDT	dichlorodiphenyltrichloroethane
DGM	digital geophysical mapping
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
ERA	Ecological Risk Assessment
ERD	enhanced reductive dechlorination
ESS	Explosives Safety Submission
ESV	ecological screening value
FFA	Federal Facilities Agreement
FS	Feasibility Study
ft	foot (feet)
ft^2	square foot (feet)
ft/day	foot (feet) per day
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
HQW	High Quality Water
ID	Identification
IROD	Interim Record of Decision
IRP	Installation Restoration Program
ISCO	in-situ chemical oxidation
IUR	Inhalation Unit Risk Factor
KGB	coaxial groundwater ventilation
LTM	long-term monitoring
LUC	land use control
LUCIP	Land Use Control Implementation Plan
µg/L	microgram(s) per liter
MC	munitions constituents

MCIEAST-MCB CAMLEJ	Marine Corps Installations East - Marine Corps Base Camp Lejeune
MCL	maximum contaminant level
MEC	munitions and explosives of concern
mg/L	milligram(s) per liter
MMRP	Military Munitions Response Program
MNA	monitored natural attenuation
MPPHA	material potentially presenting an explosive hazard
MRP	Munitions Response Program
mV	millivolt(s)
NA	not applicable
NAIP	natural attenuation indicator parameter
NAPL	non-aqueous phase liquid
Navy	United States Department of the Navy
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCGS	North Carolina General Statute
NCGWQS	North Carolina Groundwater Quality Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCSWQS	North Carolina Surface Water Quality Standards
ND	not detected
NFA	no further action
NPL	National Priorities List
NS	no standard
O&M	operation and maintenance
ORP	oxygen reduction potential
OSHA	Occupational Safety and Health Administration
OU	operable unit
PCB	polychlorinated biphenyl
PPE	personal protective equipment
PRAP	Proposed Remedial Action Plan
PRB	permeable reactive barrier
PTW	principal threat waste
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfC	Reference Concentration
RfD	Reference Dose
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SI	Supplemental Investigation
SVOC	semivolatile organic compound
TBC	to-be-considered
TCA	trichloroethane
TCE	trichloroethene
TOC	total organic compounds

TSCA	Toxic Substances Control Act
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
UTS	Universal Treatment Standards
UXO	unexploded ordnance
UXO-02	Unexploded Ordnance Site 2
VC	vinyl chloride
VOC	volatile organic compound
ZVI	zero valent iron

Appendix C
NCDENR Concurrence Letter

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Dexter R. Matthews
Director

Pat McCrory
Governor

John E. Skvarla, III
Secretary

March 12, 2013

NAVFAC Mid-Atlantic
Attn: Dave Cleland Code: OPQE
USMC NC IPT, EV Business Line
6506 Hampton Blvd
Norfolk, VA 23508

RE: Concurrence with the 2013 Final Record of Decision (ROD) for OU #14, Site 69
Soil and Groundwater
MCB Camp Lejeune, NC
NC6170022580
Jacksonville, Onslow County, North Carolina

Dear Mr. Cleland:

The NC Superfund Section has received and reviewed the Final Record of Decision (ROD) for Ou#14, Site 69 at MCB, Camp Lejeune dated March 11, 2013 and concurs that the selected remedy is protective of human health and the environment.

The State's concurrence is based solely on the information contained in the Final ROD dated March 2013 for OU#14 Site 69. Should we receive additional information that significantly affects the conclusions of the ROD, we may modify or withdraw this concurrence with written notice to the Naval Facilities Engineering Command for Camp Lejeune and the EPA Region IV. If you have any questions or comments, please contact Randy McElveen, at (919) 707-8341 or email randy.mcelveen@ncdenr.gov

Sincerely,

Dexter Matthews
Director, Division of Waste Management

Cc: David Lown, Head, PE, PG, Federal Remediation Branch
Charity Rychak, EMD/IR
Gena Townsend, USEPA

1646 Mail Service Center, Raleigh, North Carolina 27699-1646
Phone/fax: 919-707-8200 \ Internet: http://portal.ncdenr.org/web/wm

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record
1	no further action	Section 1	CH2M HILL. 2012. *Draft Expanded Site Investigation Report, Military Munitions Response Program Site UXO-02 – Former Unnamed Explosive Contaminated Range, ASR# 2.201, Marine Corps Base Camp Lejeune, Jacksonville, North Carolina*. March. Section 7.2.
2	waste disposal area	Section 1.1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina*. August. Section 2.3.
3	chemical agent	Section 2.1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 2.3.
4	chlorinated volatile organic compounds	Section 2.1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 5.2.6.
5	hydrogeologic units	Section 2.2	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 5.2.5.
6	treatment systems	Table 1	Baker Environmental, Inc. and SBP Technologies. 1998. *Final Phase I and II Treatability Report, Operable Unit No. 14 (Site 69), Marine Corps Base Camp Lejeune, North Carolina.* January. Section 2.3.
7	remedial alternatives	Table 1	CH2M HILL. 2012. *Draft Feasibility Study, Site 69, Operable Unit No. 14, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* April. Section 4.
8	human health risk assessment	Table 1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 7.
9	ecological risk assessment	Table 1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 8.

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record
10	groundwater modeling	Section 2.4	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 6.3.
11	2010 SI	Section 2.4	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 5.
12	concentrations of COCs	Section 2.4	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 2.6.3.
13	NA processes	Section 2.4	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 2.8.
14	water supply wells	Section 2.5	AH Environmental Consultants. 2002. *Wellhead Protection Plan--2002 Update, Marine Corps Base Camp Lejeune.* August. Figure 5-6.
15	exposure scenarios	Section 2.6.1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Table 7-3.
16	receptors	Section 2.6.1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 7.1.
17	cancer risk	Section 2.6.1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 7.5.1.
18	hazard index	Section 2.6.1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 7.3.3.
19	hazard quotients	Section 2.6.2	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 7.5.1.
20	UXO-02 evaluation	Section 2.6.2	CH2M HILL. 2012. *Draft Expanded Site Investigation Report, Military Munitions Response Program Site UXO-02 – Former Unnamed Explosive Contaminated Range, ASR# 2.201, Marine Corps Base Camp Lejeune, Jacksonville, North Carolina*. March. Section 7.1.1.
21	North Carolina's groundwater classification	Section 2.6.3	North Carolina Administrative Code, Title 15A, Department of Environment, Health and Natural Resources, Subchapter 2L – Groundwater Classification and Standards. Section 200, Rule .0201. NCDENR, April 2005.

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record
22	**presumptive remedy**	Section 2.7	USEPA. 1996. *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills. OSWER Directive No. 9355.0-67FS.* December.
23	**screening of technologies**	Section 2.9.1	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 4.
24	**nine USEPA criteria**	Section 2.9.2	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 5.
25	**ARARs**	Section 2.9.2	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 3.1.
26	**rebound**	Section 2.9.2	CH2M HILL. 2011. *Final Supplemental Investigation, Site 69, Operable Unit No. 14—Rifle Range Chemical Dump, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.* August. Section 5.3.4.

Detailed site information referenced in this ROD in **bold blue text** is contained in the Administrative Record.